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A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

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Index to Advertisers and Classified Index Following Reading Matter.

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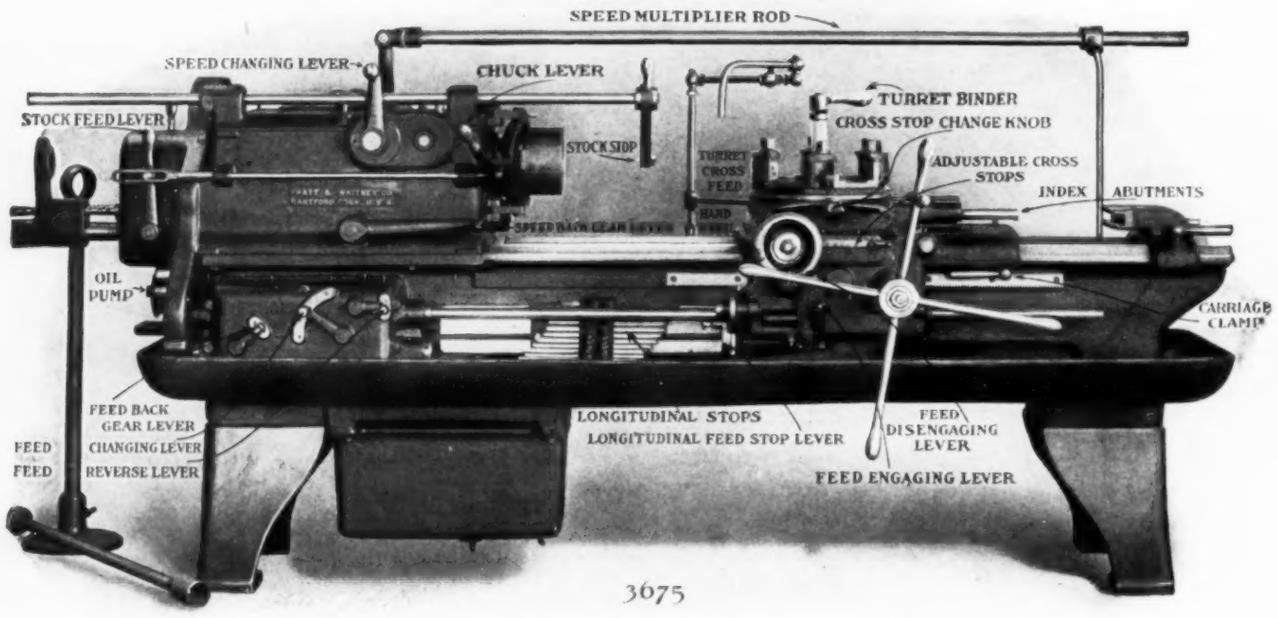

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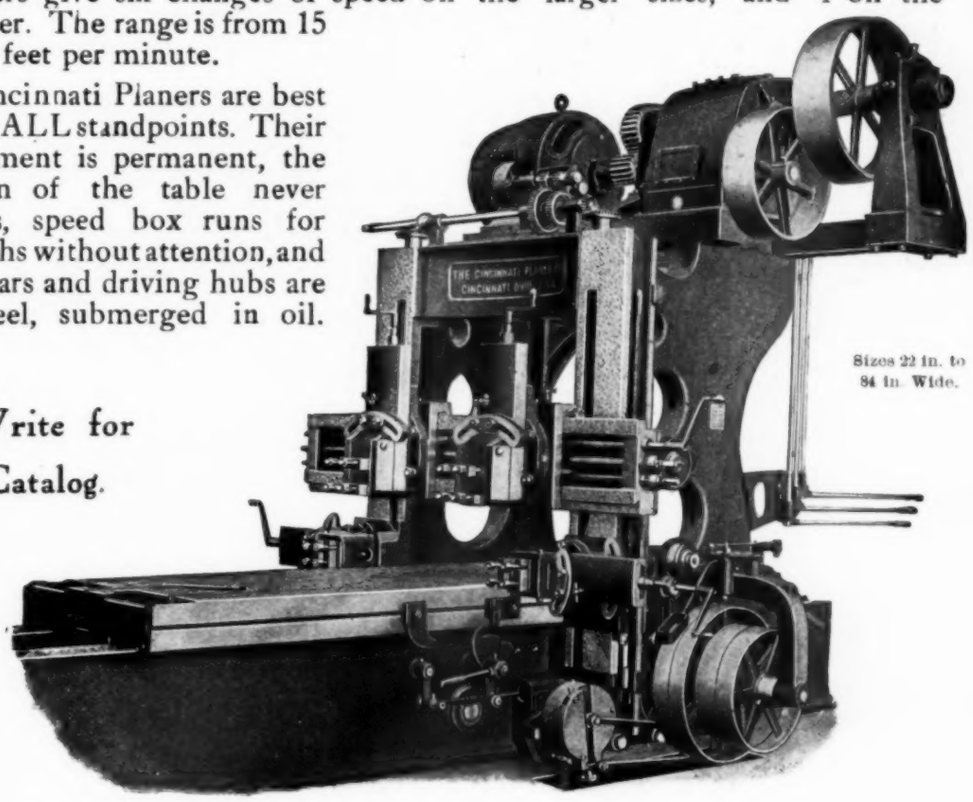

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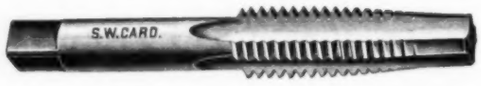

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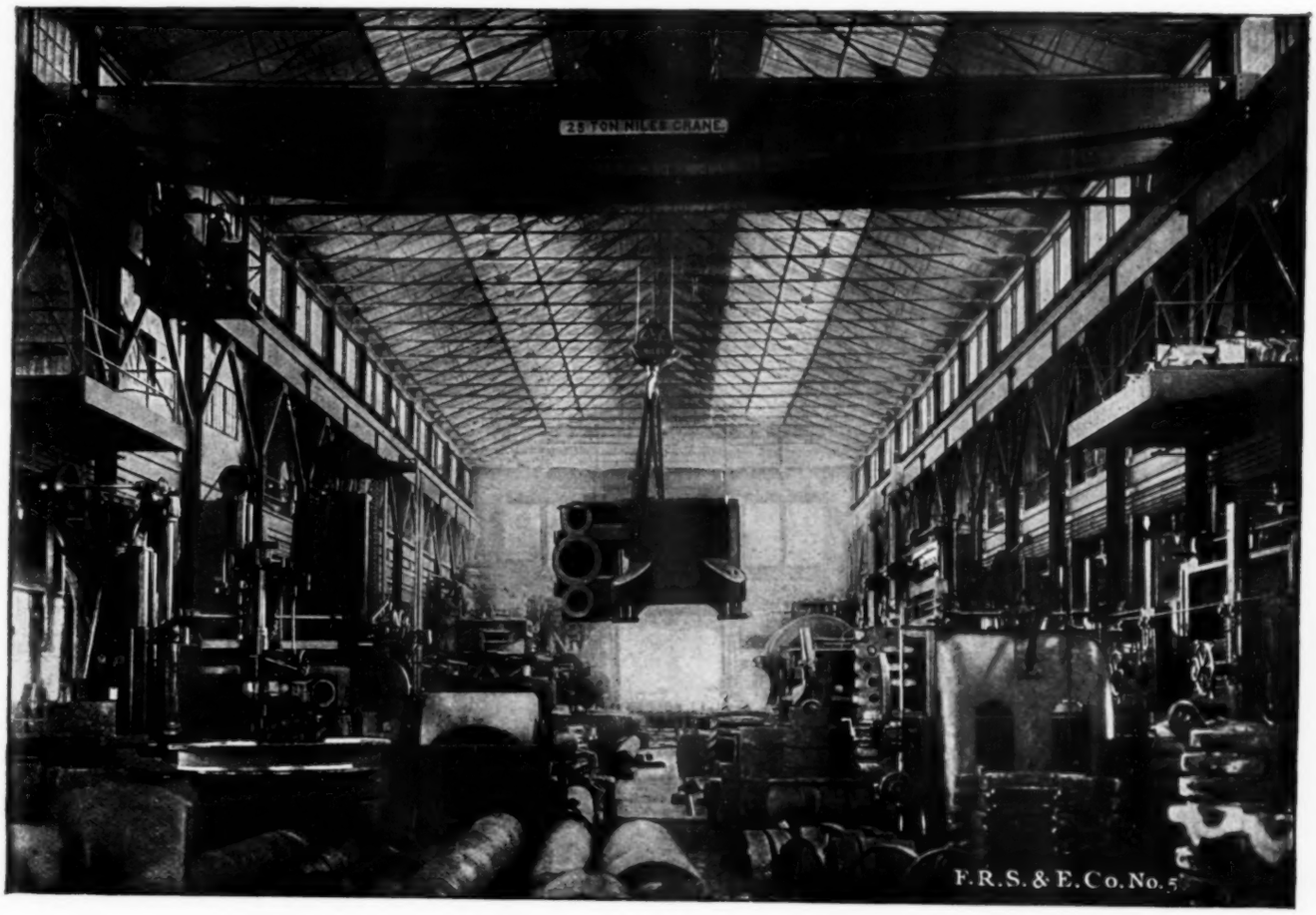

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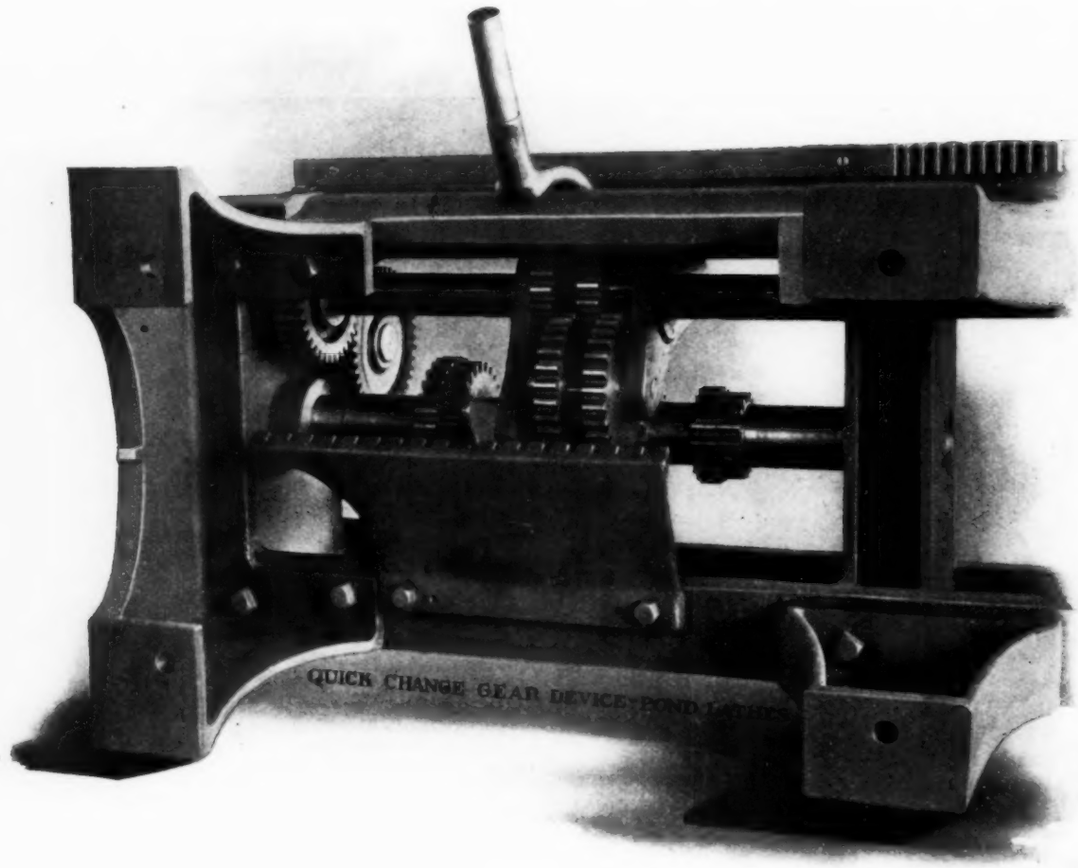

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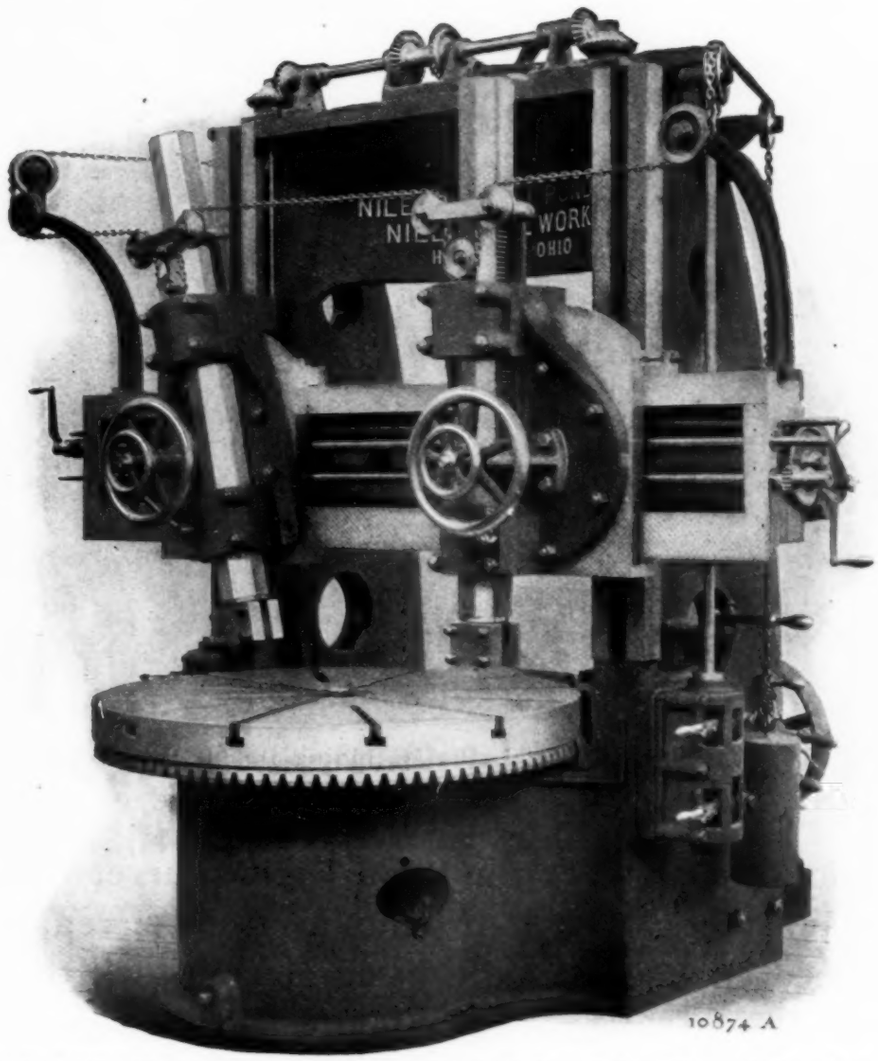

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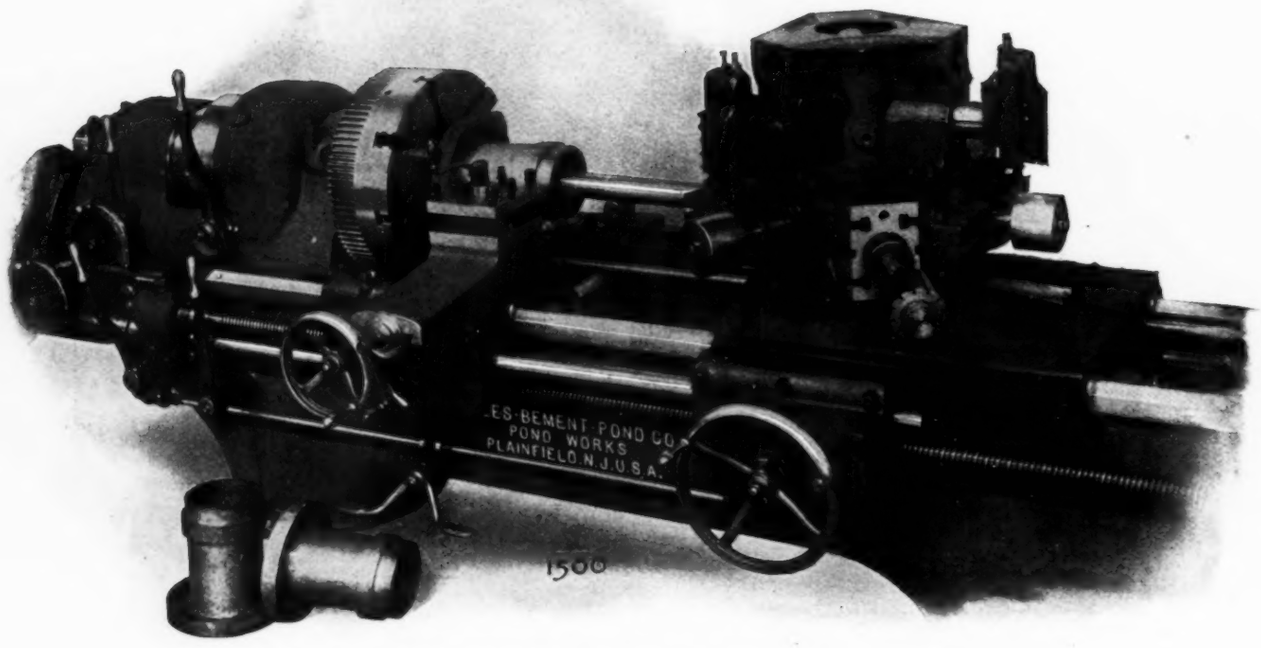

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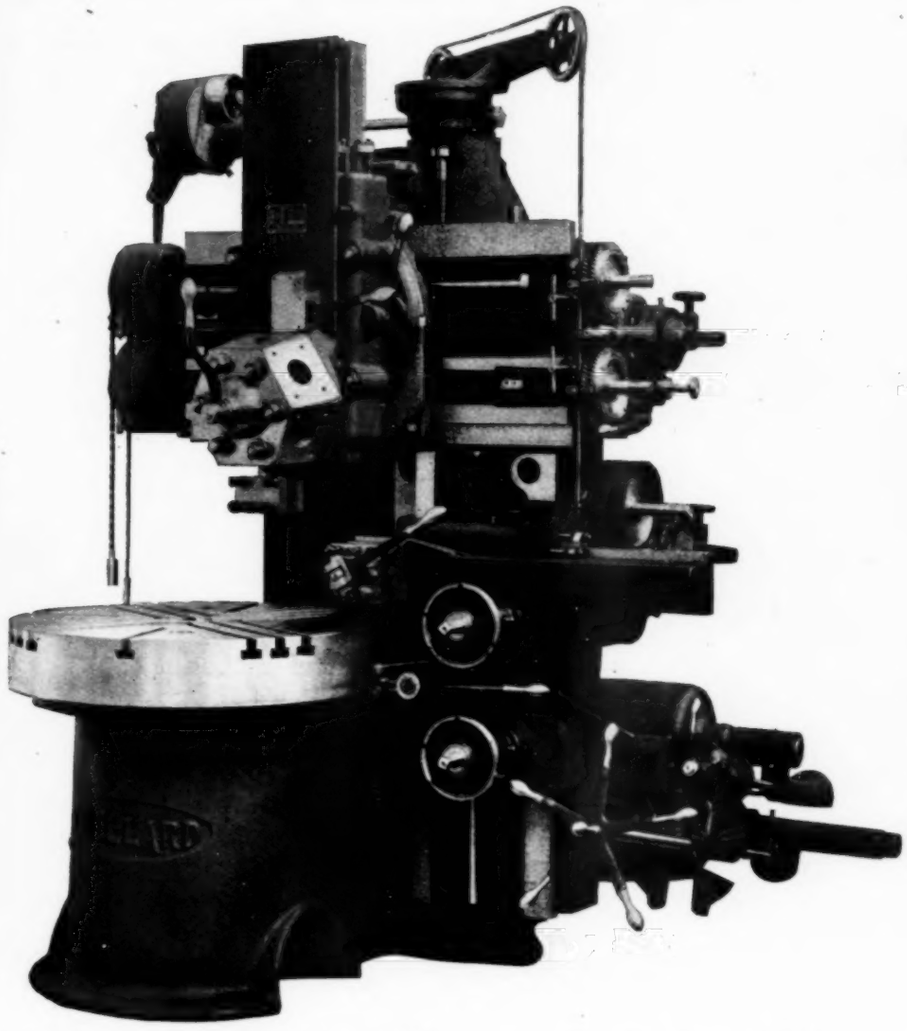

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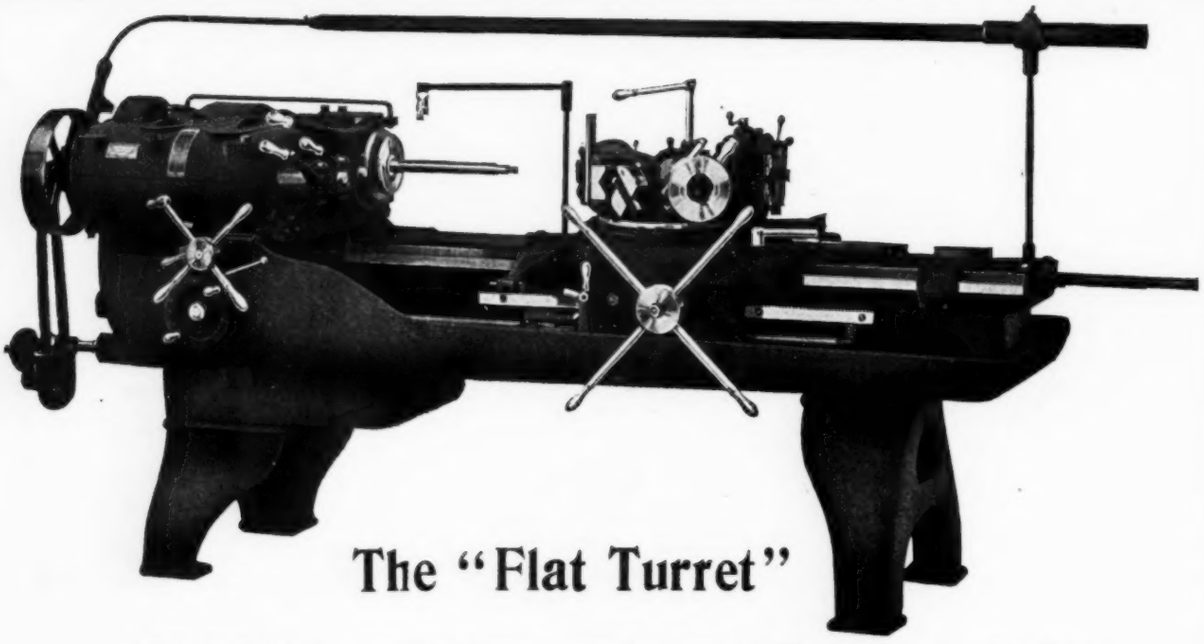

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Chloride of Barium for Hardening

The Correct Style of Furnace to Use, How Barium Chloride Should Be Handled and Its Effect When Hardening Steel Tools

BY O. M. BECKER

A common forge fire, if suitably protected, will permit fairly satisfactory results in forging high-speed steel into tool shapes; but if any considerable amount of this work is to be done, it is quite necessary that a furnace of suitable design be used. Coke and gas furnaces of approved pattern are obtainable on the market, or can be made in the shops of the user.

For hardening coarse tools the same furnaces can be used, as also can the common forge protected with a hood inclosing the fire. The results with the latter, however, are likely to be uncertain, and it should not be used, if anything better is available. The gas furnace is much the most convenient for hardening, though under ordinary conditions the coke heater also is very satisfactory. The latter is less easily controlled; or rather the temperature of the fire cannot be so readily and quickly changed, as it can with the gas furnace. The coke fire, when maintained in a properly designed furnace, does not cause oxidation of tools heating in it, for no unconsumed air reaches the center of the fire where the tool is placed. This condition, however, is secured in a properly designed gas furnace also; and the latter is preferred wherever gas is obtainable at anything like a reasonable cost.

FIG. 1. HARDENING ROOM FOR HIGH-SPEED STEEL TOOLS

Furnaces for Ordinary Hardening

The common rectangular type of gas furnace is suited to the heating of most tools; those that are of a shape or length that would become deformed by their own weight while hot being exceptions. For tools of this kind, that is, long reamers, taps, etc., the cylindrical furnace is preferable. In these the tools are introduced at the top and vertically suspended in the center of the furnace, so that there is no opportunity for their becoming deformed.

Where the rectangular furnace is used, trouble may be avoided by carefully leveling the bottom and laying upon it parallels of iron or steel rods. The size of these is immaterial except that they should be small enough to allow a lifting bar or prong to be slipped below the tools when they are introduced into and removed from the furnace. These bars can be easily adjusted to meet the requirements of different tools, or pushed to one side if desired.

Tools of the compact shape must be set upon the floor of the heating chamber and removed with tongs. Those laid upon the grids may be placed in and removed from the furnace, by means of a long flat bar, single or pronged as required, upon which the tools rest when handled. This arrangement is especially desirable, when a number of small flat tools are to be hardened at the same time but care must be taken to prevent overheating by leaving them too long without attention.

Gas furnaces, especially of the cylindrical type, should be so designed that the flame has a rotary motion. This not only reduces the chances for oxidation within the furnace to a minimum, but insures absolute uniformity in the heating.

Oxidation when Hardening

Scaling is a bothersome and expensive thing. It causes a reduction in the size of tools, and wherever they are to be applied to fine work, a refinishing or regrinding is required. Besides, in making a tool accurately to size, allowance has to be made, in the first place, for the reduction in size by scaling or refinishing.

Scaling is caused by the hot surface of the steel oxidizing when it comes in contact with the air. The metallic surface burns, just as wood or coal does when it unites with the oxygen of the air in the presence of heat. In the case of tools, it occurs sometimes within the fire, as well as outside when the tool is withdrawn for cooling. It is seen therefore that the caution already given with respect to the kind of furnace to use, is important enough to be regarded in the case of fine tools if not in others. In the absence of a furnace suitable to the purpose, as already shown, it has been a common practice to place tools in muffles, generally packed in coke, charcoal, or other suitable material, and pretty well sealed in, openings of course being provided for the escape of gases formed within the muffles.

Refinishing Tools After Hardening

The practical difficulty with this method, successful enough in the main, is that of keeping informed as to the condition of the contents of the muffle. Various sizes of tools require different periods for heating to a suitable temperature for hardening and the nature of the case is such that there can be no set rules regarding the time for heating and consequently no absolute uniformity can be maintained in the degree of hardness of tools of the same kind and size. This of itself is a serious matter, especially where many tools are required; but it is minimized as the experience of the toolmaker or hardener grows.

The oxidation of the surface of fine tools is much more troublesome because in spite of exceeding care, even when heated in a muffle, some oxidation takes place, often enough to necessitate refinishing, and generally enough to destroy machined surfaces. The removal from the muffle to the dip for cooling is never instantaneous, so that there is always some air comes in contact with the tool surface before it is plunged in the bath. If the hardening is done in an air blast ob-

viously the oxidation will be considerable. For this reason it is desirable never to use the air blast for cooling this class of tools; it does well enough for rough tools, and has some advantages for that work, though even there a fish-oil bath is more likely to give satisfactory results.

Use of Lead Bath

The troublesomeness of surface oxidation, especially with high-speed steel tools and the expensiveness of refinishing tools, which are left oversize before tempering in order to allow for oxidation and refinishing, has been sufficient to warrant considerable investigation into possible methods of avoiding the difficulties.

Because it has been used with considerable success in the hardening of carbon-steel tools, the lead bath has been one of the agencies employed for securing uniform heating in high-speed steel tools and if possible, reducing surface oxidation in tools to zero. Uniformity of heating is attained in the lead bath; but oxidation of the tool after removal from the bath and before cooling is not prevented. Lead itself also is subject to oxidation, and a scum of lead oxide soon collects on the surface of the bath. Lead melts at a comparatively low temperature, about 620 degrees Fahrenheit but can be raised to 1200 degrees without trouble. It can even be raised to somewhere near 2200 or 2300 degrees Fahrenheit, the temperature required for properly hardening high-speed steel tools. This last is rather difficult to do, and the results are likely to be uncertain. The oxidation of the lead at such a high temperature is of course considerable.

While therefore the lead bath can be used for heating high-speed tools, and may be very useful in the case of small ones, it does not prevent entirely the trouble of oxidation. None of the other metals available for metallic baths are any more suitable.

The problem has been to find a substance suitable for a heating bath which would give the required temperature without itself deteriorating too rapidly or combining with the immersed steel; and which would at the same time protect the tool from coming in contact with air after its withdrawal from the bath and before it has been sufficiently cooled to be unaffected by oxygen.

Nature and Development of Barium Chloride

A partial solution was found in Europe when barium chloride was tried. Barium is one of the so-called alkaline metals, of the magnesium, calcium (lime), and strontium group, and never occurs in nature except in compounds. The pure metal is not used in the arts. The chloride melts at a temperature somewhat below that best adapted to hardening high-speed steel, and can readily be raised to the proper temperature in a suitably designed furnace. A piece of steel when heated in a bath of barium chloride and then withdrawn is coated with a thin film which effectually preserves it from contact with the air until it is plunged into the cooling bath or cooled in the air blast.

Use was made of this circumstance in connection with the making of high-speed steel tools, but the process was not developed to the point where it could be used regularly and satisfactorily until taken up, developed, and introduced to the high-speed steel users of this country by the Firth-Sterling Steel Company, through its eastern representatives, Wheelock, Lovejoy & Company and its Chicago agency under E. S. Jackman. D. G. Clark, of this company, in the effort to work out the best possible method for treating Blue Chip tools has done much to advance the art of making high-speed steel tools; for the process is, of course, applicable to all standard brands of these tools.

A Model Hardening Room

A well equipped plant for hardening high-speed steel tools is shown in Fig. 1. This is in the Chicago warehouse of the Firth-Sterling Steel Company. The arrangement, counting from the front and right, is: Lead bath, barium chloride bath, cylindrical furnace, fish-oil cooling bath, heating surface, and pre-heating furnace. The exhausts for keeping the air good are ample.

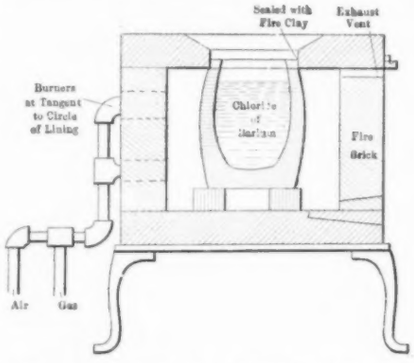

FIG. 2. FURNACE FOR BARIUM CHLORIDE

The process as now used is exceedingly simple. Commercial barium chloride, which sells for about three cents a pound is melted in a graphite crucible and brought up to a temperature of about 2150 degrees Fahrenheit in a gas furnace. A small proportion of sodium carbonate (soda ash) is added in order to prevent fuming, and the bath is ready for use.

Hardening Small Tools

Into it small tools may be plunged cold, for their temperature quickly rises to that of the bath, and in fifteen seconds to a minute, according to the thickness of the tools, they are ready for the hardening bath. The film of barium chloride which adheres to the surface of tools taken from the heating bath clings to it until brought in contact with the oil of the hardening bath, when it scales off. The surface of a tool so treated does not come in contact with the air from the moment it is plunged into the heating bath until it emerges from the cooling bath, and therefore is unaffected with oxidation.

Since the heat to which the tool is subjected is never high enough to fuse it and therefore melt off sharp edges, it comes out as perfect as it went in both as to size and surface, after the little chloride that may be adhering is brushed off. Not only is the finish precisely as before treatment, but the color is practically unchanged, so that a piece hardened by this process looks almost exactly as it did before hardening. Unless compared side by side with a tool that has not been treated, even an expert could scarcely tell from the appearance that a tool hardened by this process had been heated at all.

Reduces Distortion or Warping

The barium process obviates in large measure another frequent annoyance met with when tools are heated in the ordinary way, namely their distortion or warping, which comes from their being unequally heated on different sides, or from their sagging while very hot and comparatively soft. Immersed in the bath the tool is heated with absolute uniformity, and is partly supported by the fluid in which it lies, so that warping is practically impossible.

Small tools may be partially heated before immersion in the heating bath; it is, unnecessary, however, for tools up to, say ⅜ of an inch in thickness and it is objectionable in the case of very fine tools because of some possible slight oxidation. Tools larger than this should be preheated to a low red, a temperature at which there is little if any oxidation on exposure to the air, and then put into the bath. This obviates the danger of the bath chilling by plunging large tools in it, thus making the temperature uncertain.

Large Tools Should be Pre-heated

In the case of very large tools it is quite necessary that they be pre-heated. Another advantage in pre-heating large tools is that this may be done in an ordinary forge fire or gas furnace while other tools are in the heating bath. If this be done, care should be taken that the color does not rise above a dull red unless the tools be such that scaling does not make any difference. In pre-heating fine tools there is always danger that the heat will rise high enough to cause scaling, and it is, therefore, best to use a lead bath for pre-heating these.

The time for which tools should be immersed will, of course, vary with their thickness, and perhaps somewhat with their shape. In every case it must be long enough to bring the portions used for cutting edges to the heat of the molten

chloride. In the case of small tools this takes, as already shown, from a fraction of a minute to a minute or more. Large tools may require several minutes. Since the temperature of the bath does not readily rise much above that already mentioned, and is uniform throughout, there is little danger of burning a tool or spoiling it by soaking if it be kept in the bath longer than necessary.

HARDENING A THIN SHELL ON TOOLS

It is by no means requisite, however, that a tool be left in the bath until uniformly heated through. For most tools, especially if they be small, but more especially taps, it is highly desirable that with very hard cutting edges there be combined a center tough enough to avoid breakage, either of the body of the piece, or of the cutting teeth from the body. The barium-chloride process makes it possible and easy to harden tools so as to have just these qualities.

To secure such a result it is necessary only (annealed stock, of course, having been used in forming the tool) to immerse the tap, die, milling cutter, or what not, for a few moments in the bath, that is, just long enough for the cutting teeth or edges to reach the proper heat and then withdraw and plunge it into the cooling bath. In this way the body of the tool, not having been heated except possibly to a very slight depth, remains soft and tough, while the cutting edges are hardened to the desired degree.

INCREASING UTILITY OF HIGH-SPEED STEEL

The fact that it is possible to secure these qualities in high-speed steel, increases its utility, and should quickly lead to a much larger use in metal-working establishments. There is no longer any need for taps, threading dies, or other tools of this sort being under size or having roughened cutting edges, as was frequently the case when it was necessary to harden them in the ordinary way, for the new method entirely overcomes these troubles. It likewises disposes of the complaint formerly made that there was little advantage in high-speed steel taps because it was necessary to leave them comparatively soft in order to avoid excessive breakage.

A word of caution is necessary with this method of hardening annealed center tools. Flaws are a result of unequal contraction in a mass of metal. In heating the outer portions of a tool in the manner described, there is a possibility of doing it in such a way that when it is withdrawn from the heating bath and then suddenly cooled, the outer shell will be so strained as to open flaws. A little care used in seeing that the tool is not immersed longer than absolutely necessary for getting the required heat at the cutting edges, will greatly reduce this liability of flaws occurring.

APPARATUS FOR USING BARIUM CHLORIDE

The appliances for hardening by the barium-chloride process are not different from those ordinarily used in a suitably equipped shop making high-speed steel tools, except the hardening furnace. This is preferably cylindrical, with the burners arranged tangentially about the side and so set as to cause a rotary movement of the flame around the center, where the crucible is set. The burners should be extra large so as to produce the largest possible heat in the space around the crucible. The rotary movement of the flame insures uniform heating of the contents of the crucible. A good, yet simple furnace for heating the chloride of barium is shown by Fig. 2.

The latter, of the customary shape, is almost necessarily of graphite; and rests upon blocks in the bottom of the furnace so as to permit circulation of the flame below as well as around the sides. The supports also prevent the bottom of the crucible from dropping out. The rim is fitted rather closely into the opening through the top of the furnace, and the crack sealed with fire clay, to prevent gas from the interior of the furnace escaping, or jets of flame interfering with the tools being hardened. Gas must not come in contact with the melted barium chloride. A furnace easily modified to meet these requirements is on the market. Doubtless this, and very likely others, will before long be obtainable ready fitted for this particular work.

Some Fly-wheel Experiences

BY FRANK E. BOOTH

While I was employed in a machine shop a short distance from Toronto, where they were building gas and gasolene engines, the company had the misfortune to have a fly-wheel burst on a 15-horse-power engine which had just been tested. The engine in question had fly-wheels five feet in diameter, of the solid-hub pattern with six arms. The engine was of the usual center-crank design having a fly-wheel on each side of the bed. It was running at about 250 revolutions per minute. It was the practice in this shop to polish the fly-wheels with a piece of grindstone while the machine was on the testing stand. The man who did this work had just finished the face of the wheel and was standing at one side engaged in grinding the side of the rim, when it burst.

I heard a report like a cannon and running to the testing stand I saw an engine with only one fly-wheel. On the other end of the crank-shaft were a hub and six remnants of spokes. One large piece of the rim went through a nine-inch brick wall and landed about 60 feet from the shop. Another piece went through the roof and was found some 100 yards distant from the scene of the accident. The man who was polishing the wheel was not hurt in the least, although he had been standing with his hands almost touching the rim at the time of the accident.

A short time preceding this occurrence the firm had started to use fly-wheels with solid hubs. For years they had been using a pattern with a split hub. Since the engine was not running over its proper speed, it was generally conceded that the fault lay in the molding; the spokes may have been allowed to cool too quickly, causing internal strains which may have been aggravated by the heating of the rim in the operation of grinding.

As a result of a poor job of keying I saw a four-foot fly-wheel come off of an engine running at a speed of 300 revolutions per minute. I had often wondered as to how a run-away fly-wheel would act. This one had a clear passage before it and proceeded across the shop until it collided with the wall, where it stood rotating around its axis with the rim rubbing on the bricks until the friction stopped it.

A short time ago I was sent out with instructions to try and locate a knock in a four-cycle oil engine. The people to whom the engine belonged said that it had been knocking away for some time. The engine was not running when I arrived at the scene of the trouble, so I looked over the bearings and took up some slack on the crank pin and piston pin, and started up. As soon as the engine got up speed I became acquainted with the awful noise reported, but could not locate it. I now shut down for I was afraid to run the engine longer. I caught hold of the arm of the fly-wheel to pull the crank up when I felt slack between the wheel and the shaft. I drove the key in and started up again. The noise had disappeared.

Another job which caused some trouble was a fly-wheel on a 200-horse-power internal-combustion engine. It had two keys in the hub which had become loose several times and, of course, hammered the keys and keyseats out of shape. In dressing up the keyseats we made them somewhat wider than they were in the first place. We then sized up one keyway in the wheel and, placing the wheel on the shaft, fitted key number one, and while this key was in place we marked off the other keyway to match the remaining keyseat and cut to the lines. It gave no more trouble. The original job had been all laid out and both keyways cut before either key had been fitted.

The imports of cement in Australia in 1906 amounted to 88,919,936 pounds, imported from the following countries: Germany, 50,441,090 pounds; United Kingdom, 34,648,653 pounds; United States, 257,152 pounds; other countries, 3,572,141 pounds. The price at Sydney varies, but is at present about $2.50 per cask of 375 pounds.

Progressive Shop Education—A Suggestion*

Outline of Continuous and Systematic Course to Train Shopmen for Responsibilities of Effective Foremen, Superintendents or Managers

BY FREDERICK A. WALDRON‡

The education and training of men for leading positions in a factory is a problem which, at the present day, is receiving careful and comprehensive thought. Manufacturing interests, both large and small, have without exception educational methods of a more or less efficiency in operation in their establishments. Twenty years ago one of the leaders in the industrial world said that he saw the elimination of hand screw machines and the "personal equation" upon the starting of his first automatic screw machine. Today this factory has very nearly as many hand machines as automatics. This proportion holds equally true in many other factories.

Coincident with the industrial development of the last quarter century has been the specialization in different lines of work to such an extent that, at the present time, what is known as the old-fashioned all-round mechanic is gradually disappearing and a new element is taking his place. It should not be forgotten, however, that while this is the logical course of progress there will always be required men of ripened judgment and all-round capacity to coördinate and unify this line of specialization in order to obtain the maximum results and the minimum unit of costs.

The object of this article is to suggest a plan whereby the standard of the "personal equation" can be raised to a plane equal in efficiency to shop equipment; then the "man in front of the lathe" will desire those things which will make him a stronger, broader and better man, of more value to his employer and the community at large and capable of advancing more rapidly than heretofore in order that his earning capacity will be increased. Progressive shop education should consist of a *continuous* and *systematic* course of instruction for workmen along such lines as will enable them to assume more rapidly and efficiently positions of trust and responsibility, by developing the mechanical, mental, physical and spiritual functions uniformly in order to obtain the highest standard possible.

A synopsis of this entire article is found in Tables 1 to 5, inclusive.

Explanation of the Tables

TABLE 1

Table 1 defines progressive shop education and states the reasons why it is needed, the material to draw from, how it can be accomplished.

The examples given in this table are of those who have carried it out in the spirit rather than the letter, and represent typical cases of successful and continuous methods of management due to a fixed and well selected policy covering a period of over a quarter of a century.

The efficiency in these tables represents the average knowledge on the subject in the average shop as nearly as I am able to judge of it. The heavy horizontal lines show the estimated present efficiency, and the possible efficiency, of the groups and sections as the result of progressive shop education.

TABLE 2

The subject of this table is "Output." It gives the four principal elements relating to the output of a factory, with subdivisions.

TABLE 3

Groups, divisions and sections of the educational course required for those desiring to become foremen are the subject of this table.

TABLE 4

Table 4 gives the groups, divisions and sections required to educate the foreman for the position of superintendent.

TABLE 5

Table 5 shows the group divisions and sections for the education of the superintendent for manager.

Why Neglected—Table 1, Column B

The possibilities of decreasing the unit cost and increasing the output of the average industrial establishment at the present day ranges from 15 to 200 per cent. above its present output, depending on the character of the product, method of manufacture, type of machinery and intelligent help.

The last 10 years may be well described as the decade of "intensified production." Our attention has been given to the development of the art of removing metals and building machinery for that purpose, thus, while the labor problem has been exceedingly troublesome and annoying, there has been no concerted effort on the part of manufacturers to raise the physical and mental standard of the American workmen to a point where they will average as high as the tool and equipment development. To a certain extent it has been a period of high speeds, high pressure and "high hustle" in attempting to obtain high efficiency. False motions do not count except to tire out the workmen and make

A	B	C	D	E	F	G
DEFINITION.	WHY NEGLECTED.	WHY NEEDED.	WHAT IS REQUIRED.	MATERIAL	HOW ACCOMPLISHED.	EXAMPLES
A Continous and Systematic Course of Instruction for Workmen, Along Lines that will Enable Them to Assume More Rapidly and Efficiently Positions of Trust and Responsibility.	1. Possibilities Not Fully Realized. 2. Too Much Business. 3. Not Appreciated. 4. Too Much Machinery, Not Enough Humanity. 5. Allowed to Drift: (*a*) Lack of Funds. (*b*) Lack of Push. (*c*) Lack of Head. (*d*) Change of Management. (*e*) Too much Paternalism.	1. To Increase Output. 2. To Retain Industrial supremacy in Future. 3. To Increase the Strength and Life of American Workmen 4. To Provide Leading Men. 5. To Provide New Blood. 6. To Relieve Strain on Those Carrying an Overload.	1. A Broader Spirit in Shop Management. 2. More Equal Distribution of Load. 3. Tenacity of Purpose. 4. Strong Physique. 5. Strong Minds. 6. Clean Morals. 7. Broader Views: (*a*) Human Nature. (*b*) Mechanical. (*c*) Shop Organization. (*d*) Commercial Organization. 8. Create Desire.	1. Graduate Apprentices. 2. Technical Graduates. 3. Journeymen. 4. Gang Bosses. 5. Special Applicants. 6. Assistant Foremen.	1. Adoption by Engineering Societies. 2. Appoint Committee. 3. Provide Funds for Preliminary Wk. 4. Perfect Course. 5. Have Course Indorsed by Manufacturing Interests. 6. Provide Literature, Lantern Slides and Instructors. 7. Provide Fund for Permanently Carrying on Wk. 8. Obtain Indorsement of Educational Institutions.	1. Brown & Sharpe 2. R. Hoe & Co. 3. Smith & Wesson. 4. Warner & Swazey.

TABLE 1. UNDERLYING PRINCIPLES AND FACTORS IN PROGRESSIVE SHOP EDUCATION.

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‡Industrial engineer, 37 Wall street, New York City.

the "unqualified boss" think their makers are working.

This is due largely to the strife for commercial supremacy and, in the heat of the fight, the present only is considered; the future supply of help is overlooked. It is true that some of the more conservative concerns whose work has been marked by a steady increase since 1880 (see Table 1, Column G) have maintained and continued a fixed policy, the results of which have been equivalent in a degree, to progressive shop education.

Why Needed—Table I, Column C

The scarcity of good men with well directed initiative has long been a recognized fact. Coupled with this we find that responsible heads and sub-heads of different corporations are overburdened with the details and worries that make them old men before their day, or, being unable to stand the pressure, cause them to drop by the wayside. The only explanation or excuse for neglect of a function so vital to the efficiency of any plant is the failure to realize its full value as an asset when universally carried out. Reference to the present, possible and ideal efficiency (shown graphically in the table) will give an idea as to its possibilities.

Business increase and the use of necessary funds for it have so absorbed the industrial minds and finances that time has not been taken to look into the value of such a course. Many industrial plants of the non-progressive type have not had the subject presented in such a way that "there is money in it" and have not been brought to the point of appreciating it.

Energy and money are expended freely on efforts to reduce labor costs by machinery; in fact, any firm who can see a 10-per cent. net saving in a machine will invest in it. How many will spend the same amount in proportion to raising the standard of labor efficiency by education, proper organization and routing? In many places ideas of this kind have been conceived, started and allowed to drift, finally disappearing in a depleted bank account and the "I told you so" of the man with the large sledge. That the drifting or gradual disappearance of new schemes of more or less merit is considered meat for "shop gossip" and a source of financial loss to the management must be admitted, and is generally traced to one or more of the five causes in Table 1, Column B, No. 5.

With a well equipped bureau, provided with funds and administered properly, much could be accomplished by allowing those firms desiring to avail themselves of its advantages to pay a fixed sum of money which would be much less, as a whole, than the miscellaneous funds laid aside for experiments along this line which, in most cases, are started in a sincere spirit but a decidedly amateur way and are abandoned either on the eve of success or when a dismal failure has been accomplished. Much good can come from these random efforts but the grand total is not what it could and should be.

One of the most serious problems confronting the industrial world at the present time is to maintain the proper mental and physical balance in factory help. The pace that has been set by the various plans of intensifying production has developed the fact that comparatively few people are able to stand for any great time the pressure which they are required to exert to keep up to the standard of modern requirements. One large factory in the Middle West employing 5000 people hired over 7000 in one year, or a one and two-fifths annual change of the entire personnel. Various reasons are given for this, but, when sifted down, we find the important ones are the two following:

A. Either the mental and physical caliber will not admit of reaching the requirements and the party is discharged.

B. Or the party realizes this fact upon taking up the work and leaves before he is discharged. This does not apply to workmen only, but to all grades of help from the helper up to the presidents of modern manufacturing enterprises.

Literature of all kinds is being circulated through different channels suggesting methods of preserving the health and improving the mind. The means of educating the average mind to care for and preserve a mental and physical balance is at hand, but no well directed and concentrated effort has been made by the owners of large interests to systematically and efficiently put into practice the theories and results of scientific investigation along these lines for the benefit of their help and themselves. Welfare work, as practiced in many plants today, is a hollow mockery as compared with the results obtainable. It is a means of advertising. While some good is accomplished, the results for the money spent are doubtful as the object is primarily and finally selfish and, in many cases, done in a spirit of paternalism rather than a spirit of uplift. Taste is a matter of education and it is folly to place before a person luxuries to which they are unaccustomed. Richard Cobden and John Bright had the true conception of progressive shop education.

It would, therefore, seem reasonable that, in order to have such things successful from a commercial and humanitarian standpoint, a desire should be created in a man to have those things which are in the end for his own best good. Do not *give* but let him *pay* something for what he receives, either in money, time or effort.

Education in this country and Europe has reached its advanced stage through systematic and concerted action on the part of great educational institutions. A graduate from the technical schools of all countries has the same standing in his profession insofar as his training is concerned. Grammar schools, high schools and colleges have a fixed line up to which the graduate must come and which is universally recognized.

For the man who has learned a trade, and is the bone and sinew of our American industries, no systematic or well defined organization is in existence to direct his education or suggest to him the ways and means by which he can better his mental and physical condition after his apprenticeship has expired. In order to cope with intensified production for the maximum time and to withstand the strenuous life he must be a strong man, both mentally and physically.

Many shops are suffering in their output more from the lack of efficient subexecutives than from any other cause. By giving careful study to the mechanical and physical causes which tend to decrease your output and increase your cost, you will find that there is not a single technical or mechanical problem which cannot be revised or solved, provided time and money are spent in doing so.

"It is the little fox that destroys the vine," and, from an experience covering 28 years, I am convinced that the element which tends to destroy and hamper the output of any factory is the "personal equation" which covers specifically "holding on to your job," "petty jealousies," "mental attitude," the temper of the superintend-

Brains.	Labor.	Materials.	Machinery.
1. Imagination. 2. Conception. 3. Design 4. Construction. 5. Application. 6. Perfection. 7. Results.	1. Skilled: (*a*) Brain. (*b*) Hand. (*c*) Brain and hand. (*d*) Machine. 2. Unskilled: (*a*) Shovelers. (*b*) General helpers. (*c*) Machinery helpers. (*d*) Machine hands. (*e*) Bench hands.	1. Iron. 2. Steel. 3. Copper. 4. Coal. 5. Others.	1. Automatic Machinery. 2. Heavier Machinery. 3. High Speed Steel. 4. Jigs and Fixtures. 5. Electric Drive.
Present Efficiency 75%	Present Efficiency 50%	Present Efficiency 90%	Present Efficiency 75%
Possible Efficiency (Ideal 100%), 90%	Possible Efficiency (Ideal 100%), 80%	Possible Efficiency (Ideal 100%), 95%	Possible Efficiency (Ideal 100%), 90%

Present Efficiency Average for Table 2, 72.5%.
Possible Efficiency Average for Table 2, 88.75%.

TABLE 2. ELEMENTS CONTROLLING OUTPUT.

ent, assistant superintendent, general foreman, sub-foreman, and gang boss. The "personal equation" cannot be eliminated, but it can be educated. If those who have had experience in the managing of help will go through their records they will find that a surprisingly large number of good men have been let go, or transferred, directly, or indirectly, for the above reasons.

The man with the perfect physical and mental equipoise is of necessity a leader; that leaders are required hourly in industrial development is an admitted fact. The problem is to first find the material and then develop these leaders. Men who lead others and say "Come on, catch me if you can," who lead by their own enthusiasm and inspire it in others, who come to you and say "What do you want done next?" instead of "When will you have it done?" are the men needed.

What is Required—Table 1, Column D

Thoughts from an initiative mind are more enthusiastic and carry farther than those from a passive mind. Well directed enthusiasm evolved from a trained mind is the essential element in factory success. By education the mind can be trained to do or suggest doing that which is required by those in authority, and it is much better to *lead* than *drive*.

If the sub-conscious mind can be dominated by the conscious mind the element of "jealousy" and "holding your job" can be largely eliminated by the education of the conscious mind to a point where it dominates the life and habits of the individual.

Large amounts of money have been spent by various firms in a more or less aimless way to obtain these results, but no concerted effort has yet been made by all of these firms whereby the maximum results can be obtained by a well directed and systematic method of education and training.

Material—Table 1, Column E

If a person has not the ability or judgment that is capable of development along the line of his chosen calling, no amount of education will inject these qualities into his mind. Those, however, who have the natural qualifications can, by a systematic course of training and education, develop more efficiency in two years than they could in six years under ordinary methods. This is due (in my judgment) to the fact that while a man's efficiency as an individual may be materially increased, the greatest good results from his influence over others, and the tendency to create a higher plane of ethics among the rank and file of the average shop.

We will assume that all well regulated factories have some form of apprentice system. As soon as an apprentice has served his time (during which he has been under observation) he is placed in some department as a journeyman, or, if the boss takes a liking to him, is shifted

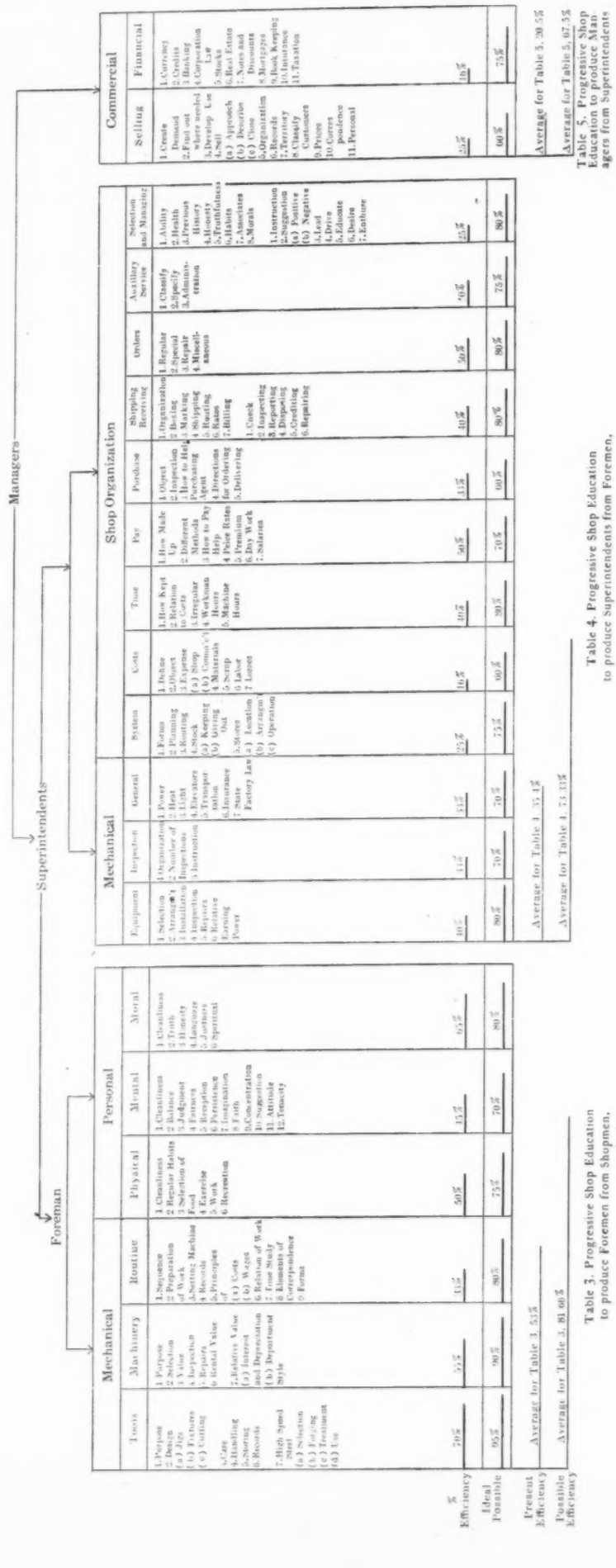


Table 4. Progressive Shop Education to produce Superintendents from Foremen.

Table 3. Progressive Shop Education to produce Foremen from Shopmen.

Table 5. Progressive Shop Education to produce Managers from Superintendents

from place to place until he is made a "gang boss," then an assistant foreman or foreman; possibly assistant superintendent or superintendent. All of this time he has been kept, to a certain extent, in a rut, with the exception of where his own ambition or exertions pull him out of it. Systematic education, however, of the apprentice is dropped at the time he has become a journeyman, and he must then shift for himself. It should not be dropped at this point, but continued if he has the natural qualifications.

How Accomplished—Table 1, Column F

Oftentimes a good man is lost for the lack of someone to discover the power that is lying dormant within him. Progressive shop education will bring it out and to the attention of those in authority much more efficiently than any other method. Then again circumstances beyond the control of the individual are such that he cannot afford to make a change and get the proper experience, although he may desire it. It is to bring out, grade and perfect these natural abilities that should be given paramount attention on the part of leading manufacturers.

Through the efforts of engineering societies more has been done to standardize apparatus and methods than by any other means, but the noblest and greatest work remains yet to be done in raising the standard of the American workman by concentrating their efforts on means whereby his taste will be guided and educated along those lines which will make him better able to cope with the tasks which will be demanded in the coming struggle for industrial supremacy of the world.

"It is not a theory but a condition that confronts us." To turn out the work and maintain the pace we must have better men; strong men that can stand the strain. Those who have to do with the operating end of the factory will admit that the number of this class of available men is not on the increase. Sparta recognized this condition centuries ago; long before the time arrived to defend their national life every Spartan was a trained warrior. Let American industries profit by the Spartan example. To maintain our supremacy we must have the best, strongest and healthiest mechanics in the world, and, unless we take time by the forelock and train and educate them, the battle will be lost ere we realize it.

The time required to cover the course is as follows: Total number of subjects, 173; allow for additional subjects, 27; making a possible total of 200.

These 200 subjects, allowing an hour and a half for each lecture, would require 300 hours. If we set aside 35 weeks of the year, during which time those taking the course should be compelled to go two nights a week, it would require about three years to complete the course, which is not an unreasonable time and would not involve serious expense on any firm if handled systematically and from a central point of administration.

Engineering education has been purposely omitted as the technical schools and many firms are providing for this at the present time with all the efficiency that can be desired, and I wish to emphasize that the lines laid out in these tables relate purely to the administrative and productive end of the factory and the subjects which pertain to them.

The averages of the different sections of the table are not infallible, and are a matter of judgment on my part from my experience in different factories. They are not beyond criticism, and I would be glad to have any suggestions relating to them that would throw more light on the subject.

Some Vicissitudes of the Job Shop

By J. G. Dornbirer

He was an energetic young man and a good mechanic; but all indications pointed to the fact that he neglected to study human nature, one of the prime factors which enter into the successful operation of a job shop in a country where charging 50c. per hour is considered an advanced stage of brigandage. After having purchased the necessary machinery this young man swung his shingle to the breeze, announcing that he was ready to take the consequences. Well! after about six months he was known as a robber; especially by those who purchased from 50 cents to a couple of dollars worth of his services annually. In justice to this young man, I will say that his constant aim was to charge a fair price until he discovered that it made very little difference whether he charged what was right, or whether he tossed up a nickel to ascertain whether the aforesaid price should stand or be doubled. He knew that the opinion of most of his clients regarding his honesty was the same.

Well! anyhow, experience came faster than money. After arguing for about an hour with a customer whether 5 or 10 cents was the proper price to charge for a little repair job on an apple parer, the young boss told Joe to take charge of things until he had recovered sufficiently to resume. Joe was an old soldier; a good all-around man, who claimed that he could read human nature from right to left and then down through the middle. Well! at that psycological moment one of the most docile looking creatures the sun ever shone upon entered, and inquired for the boss in about the same manner that a demure young lady would ask a male clerk to show her the latest brand of corsets. Joe answered that he was it and that he was at his service. They talked for about 10 minutes. Then Joe went over and talked to the boss for a few minutes, washed up, changed his hat and both entered the stranger's buggy and disappeared down the pike.

Now I will relate what happened to Joe in his words. However, knowing very well that the American Machinist would not publish what Joe said for the first five minutes after he returned, I will omit that part of it. It was very spicy though. "Well! we drove about a day's march and landed at the edge of a regular wilderness. We tied the horse and walked about a mile into the woods, when we finally arrived at a sawmill. About a hundred yards away over the fence was another. My clock showed four-thirty. You see this ——————— told me both mills were his and that he would give me one in payment for repairing the other. After looking them over, we came to an understanding. Then we got into the buggy and drove about a hundred rods to the front of a nice house. He said he lived there and he supposed his wife was waiting on him for supper. Then he suggested that if I took the road leading a little southwest by west, and then went straight ahead for about three miles, I would come to a town where I could get the night train for home. Why, he never asked me in to take a bite! He knew I didn't have my lunch with me. I don't believe he lived in that nice house; all a bluff.

"Well it was getting darker than the panic of '73, but I finally got there and was told to walk four miles up the track as the train did not stop in the town. Gee! I was hungry! I hadn't a cent; you see it was four days after pay day. Well! I started up the track and got to the next hamlet at 9 o'clock, only to be told that the night train did not stop there. By this time my stomach was so empty that I was afraid that it would collapse. Well! there was a presidential campaign on, I heard some great hollering so hiked over to the center of the disturbance. The speaker was from my town, I told him my troubles and he asked me to ride home with him; this was after he got through. All the way home he bored me with politics, and gee! I was of a different political complexion. We finally got home about four in the morning. My, what a long ride! I did not know I was so far away from home. Why, I haven't been so far away since the war."

In about three days two teams drove up in front of the shop with a sawmill aboard. We repaired it and had instructions to send it to a place in Arkansas, (which the inexperienced young boss did, notwithstanding Joe's objections) with the promise that the other mill would be sent in as soon as the present job was finished. Needless to say, it never came. So we went after it and barely escaped arrest for stealing a sawmill. We were stopped just in time, and were informed that the mill and house close by did not belong to the aforesaid, docile looking individual.

The Time Required for Machine Work—II

Examples of Automatic Screw-machine Work That Help in Estimating or in Selecting the Best Types of Machines

BY FRED H. COLVIN

If any one man could always know just what machine was best adapted for each piece of work in his shop, he would be invaluable, and if he could have the same knowledge of the next shop he went to, there would be many good positions looking for the one man, for it is safe to assume there would never be but one such paragon alive at any one time.

The proper selection of tools is a vital point in the management of any shop and anything which aids in this is of value to the shop, to the manager and to the workmen who are operating the various tools. If it happens that you visit some other shop and find they are getting more work out of a certain machine than you are, you immediately investigate to see whether your work is adapted to that machine, whether it has the right tools, whether the operator is getting the most out of it or whether another machine would do it better. In any case you want to know the reason. True, it often happens that the work cannot be compared with accurate results; it may be very much harder material, the quantity may be much less or that great accuracy is desired; any or all of these conditions offset the output. But in spite of these differences it is well to know what is being done by others and to see how your own work compares with it, either on the same or different types of machines.

With this in mind I have endeavored to collect from various sources, data as to a variety of work and to have this include as many details as possible. In some cases these are not as complete as might be desired, while in others they seem to cover about all the points that affect the work.

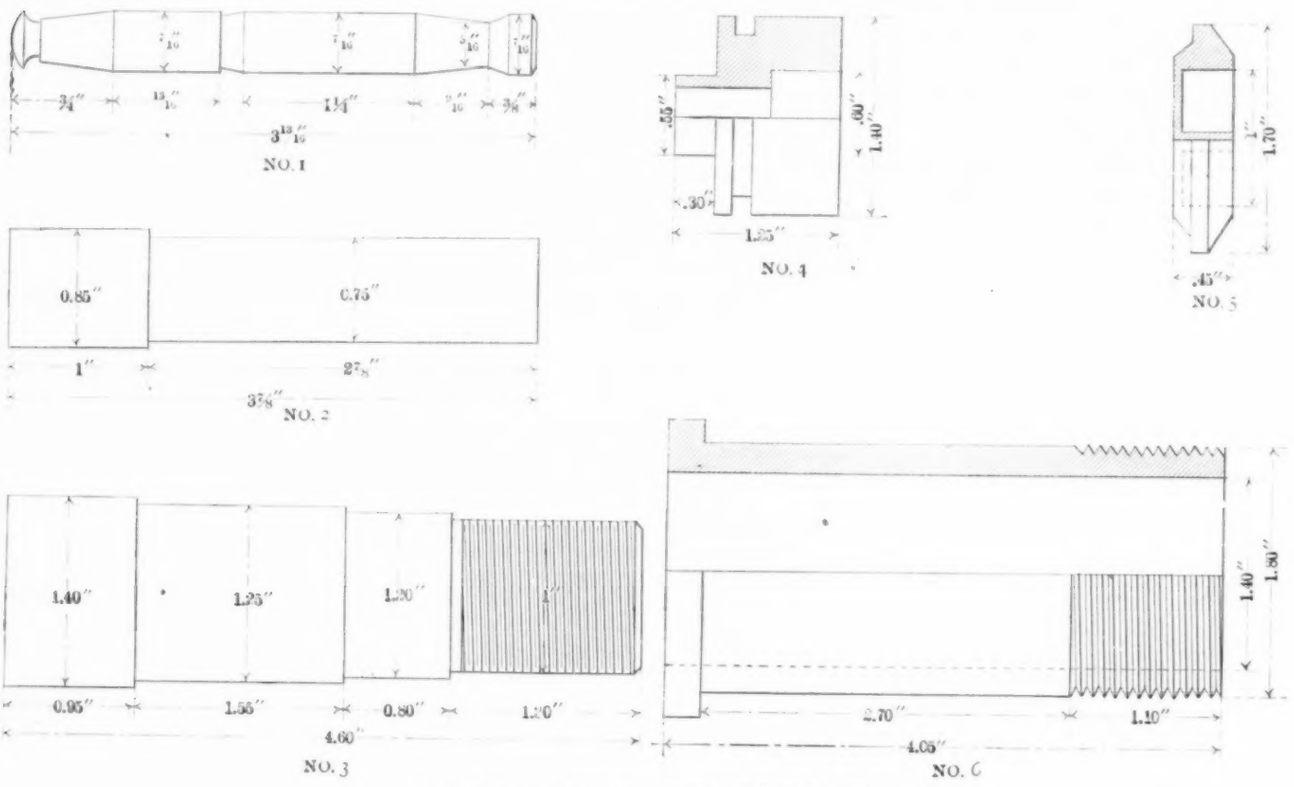
It is not supposed that any of the examples will exactly fit other work, but they should afford a basis for comparison that will be helpful in many cases. It is not the intention to give exhibition performances but rather to show what can be expected in average work, although this may not always be the case in the figures given. Neither is any comparison of machines intended or desired, as each has its field in which it can do its best work, and if we can keep a machine on the work where it gives best results, the work is sure to be more satisfactory to all concerned.

The examples given in this article, together with the details of time and tools, were supplied by the Cleveland Automatic Machine Company from work done on their machines.

Fig. 1 was a castor stud made for Tucker & Dorsey Manufacturing Company, and finished to size.

Stock ½-inch cold-drawn 0.15 carbon steel.

Combination forming and cutting-off tool used on front of cross-slide. Forming tool used on rear of cross-slide. Steady rest in tailstock to support forming cut



EXAMPLES OF AUTOMATIC SCREW MACHINE WORK

Time required by combination tool, 17 seconds.

Time required by forming tool, 13 seconds.

Total, 30 seconds.

These tools were made from high-speed steel. Cutting speed about 80 feet per minute.

Fig. 2 was a foreign job, made from 1 15/16-inch cold-rolled 0.15 carbon steel. The details are:

Box mill used in tail stock. Special cut-off tool used on front of cross-slide.

Time required for milling cut, 2 minutes 10 seconds.

Time required for cutting off, 40 seconds.

Total time, 2 minutes 50 seconds.

Tools were made from high-speed steel. Cutting speed about 80 feet per minute.

Fig. 3 is another foreign job, made from 1½-inch cold-rolled, 0.15 carbon steel. This has four diameters and the tools were:

Box mill to rough four diameters. Special box mill to taper large diameter and part next to thread and to shave straight diameter. Modern self-opening die used in combination with third spindle speed attachment to give slow speed for threading. Cut-off tool on rear of cross-slide.

Time required for roughing mill cut, 2 minutes 45 seconds.

Time required for finishing mill, 2 minutes 25 seconds.

Time required for threading, 20 seconds.

Time required for cutting off, 50 seconds.

Total time, 6 minutes 20 seconds.

These cutting tools were all made from high-speed steel. Cutting speed about 85 feet per minute.

Fig. 4 is a piece for the Garford Company made from 1½-inch cold-rolled 0.15 carbon steel. The tools are:

Special center drill to rough large hole. High-speed drilling attachment to drill small hole. Roughing counterbore in solid holder. Finishing counterbore used in floating holder. Forming tool on front of cross-slide. Cut-off tool on rear of cross-slide.

Time required for roughing center drill, 50 seconds.

Forming and drilling time combined, 2 minutes 25 seconds.

Time required for roughing counterbore, 1 minute 30 seconds.

Time required for finishing counterbore, 1 minute 25 seconds.

Time required for cutting off, 12 seconds.

Total time, 6 minutes 22 seconds.

The tools were made from high-speed steel. Cutting speed about 80 feet per minute.

Fig. 5 was made for the White Sewing Machine Company of 1¾-inch cold-rolled 0.15 carbon steel.

Hollow counterbore for roughing. Hollow counterbore and special holder with cutter to face taper on front. Forming tool. Special hollow mill used in high-speed drilling attachment to shave small stud in center of hole. Cut-off tool.

Time required for roughing counterbore, 2 minutes 10 seconds.

Time required for finishing counterbore, 2 minutes.

Time required for forming tool, 1 minute 35 seconds.

Time required for small hollow mill, 35 seconds.

Time required for cutting off, 1 minute 30 seconds.

Total time, 7 minutes 30 seconds.

Above tools were made from high-speed steel. Cutting speed about 80 feet per minute.

Fig. 6 shows a sleeve made for one of the automobile companies that are now out of business. The stock is cold-rolled 0.15 steel.

The tools are center drill. Oil-tube drill. Forming tool. Die holder and solid die using 3d spindle-speed attachment to give slow speed for threading. Floating reamer with oil feed. Special cut-off tool. Machine fitted with oil-feed attachment, with six holes in turret.

Time required for centering, 35 seconds.

Time required for drilling, 5 minutes.

Time required for reaming, 3 minutes 35 seconds.

Time required for threading, 1 minute.

Time required for cutting-off, 28 seconds.

Total time, 10 minutes 38 seconds.

Allowance for grinding outside diameter 0.010 inch. All tools were made of high-speed steel. Cutting speeds used, 75 to 90 feet per minute.

These six examples, all of low-carbon steel, give such a variety of size and kind of work that it should be of assistance in estimating on similar, in comparing this with your present output or of judging whether some of your work could be done to advantage on an automatic machine.

Clearing Out Shop Drawers—Round Boring-bar Cutters—Output of Automatic Machines

By John R. Godfrey

Few of us realize how much material can find a resting place in the shop or bench drawer of the average shop. A friend of mine has just taken hold of an old shop to infuse the spirit of the times into the work and found a dearth of small tools in the tool room. So as a result of former experience, he started a crusade on the bench drawers and the collection of junk, with incidentally quite a lot of serviceable taps and drills and reamers that were unearthed, was quite surprising. These he is having examined and measured and such as can be used will go to the tool room, the others to the scrap heap. Then he found centering work being done in lathes and was about to order a centering machine when he found two stored away in the corner behind some stock that had never been used. These are in commission and the lathes doing the work they are designed for.

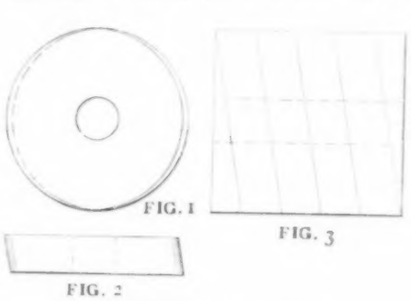


FIG. 1 FIG. 3

FIG. 2

ROUND BORING-BAR CUTTERS

A Boring Bar with a Round Cutter

This man's experience is wholly against the use of the regular reamer for machine work. He uses the rose reamer when he wants a hole true to size, but does not depend on the reamer with its wide flutes, small lands and excessive clearance. These he has difficulty in keeping to size and has about abandoned them. For a roughing reamer he uses a tool like Fig. 1 with a cutter inserted into the end of the bar. The method is old, but the cutter itself is not used in many shops that I run across.

These cutters are simply steel disks which have been turned on the outside so as to have cutting edges at *a a* which is exaggerated a little, but which shows how it acts as two single-point tools and trues up a cored hole or one which runs out of true, very nicely. Another way to make these cutters is to turn up a bar as in Fig. 3 and bore it for the holding screw. Then cut the disks off on the angle as shown, either with a cold saw or in the milling machine with a slitting saw. This is cheaper and easier than the other way. The cutters are held in the front end of a boring bar and by slacking the clamping bolt and turning the cutter a trifle, new edges are presented and the diameter is kept to size without difficulty.

Output of Automatic Machines

There is often a lot of misapprehension about automatic machinery and its output as many think it must be able to turn out more work than it is possible to do by hand. But in the majority of cases this is not true with a single machine, as a good operator can, as a rule, turn out more pieces in a day on a hand machine than an automatic will do. This is because the operator can take advantage of every move, can run the carriage up to the work very fast and will lose less time than the automatic in making changes from one tool to the next. Where the automatic makes its great gain is in allowing a man to run from two to six machines at once.

This brings out the question of careful camming so that there should be as little lost time as possible between operations. We have all seen machines carelessly set up so that the slow feed would begin an inch or even two, before the proper time, which means lost time on every piece and a big reduction in the output of the machine. Unless this is carefully watched, hand operators will show an even greater saving in time.

German, Belgian and American Crane-lifting Magnets

By Frank C. Perkins

Electro-magnets have been successfully utilized during the past few years for the purpose of lifting parts of machinery, finished and unfinished castings, rails, sheets, ingots and pigs. Recently great progress has been made in the application of such magnets in the crane industry. An ingenious crane equipped with lifting magnets has been placed in operation at the Georgs-Marienhutte in Osnabruck. At this German installation the magnets proved successful even while the machinery was worked to its utmost capacity. It was necessary to transport hot as well as cold ingots. When it is remembered that it is impossible to raise ingots of a temperature of over 750 degrees Fahrenheit with a magnet, the reason for a second lifting appliance is evident. This consisted of tongs controlled from the operator's cab and furnishing two tons lifting power in addition to that of the magnet.

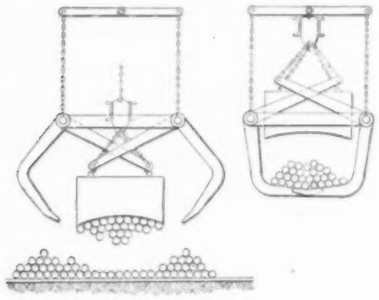


FIG. 1. GERMAN LIFTING MAGNET WITH SAFETY DEVICE

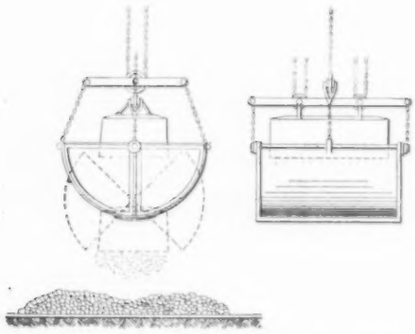


FIG. 2. GERMAN LIFTING MAGNET WITH SHELLS

While lifting magnets are used in iron and steel plants many engineers do not believe that a rational and cheap operation of them is possible. It is evident, however, that the loss of time in the ordinary working of electric cranes by means of chains is not taken fully into account. No time is lost in lifting by means of magnets, as they are lowered, receive their current, pick up the load and are raised again with a great saving of time over the chain method. The operation of detaching the load is equally quick and simple. Another interesting feature is, that the capacity of a lifting magnet may be regulated at any time. It is, therefore, possible to raise a number of sheets together and then drop them singly. There is also advantage in placing ingots or other pieces directly side by side and without using supports. The general criticism has been made that electro-magnets are not reliable and safe for lifting purposes, for if the objects being transported strike against an obstruction, or if the current is interrupted they may drop and endanger life and property.

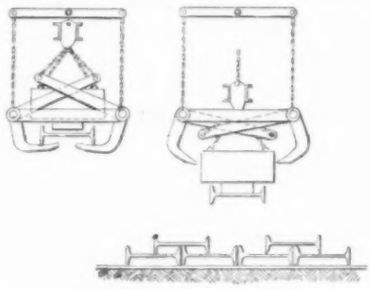


FIG. 3. GERMAN LIFTING MAGNET WITH GRIPPER JAWS

The accompanying engravings, Figs. 1, 2, 3 and 4, show forms of German magnets for crane-lifting service with protective appliances in the shape of grippers or jaws. They were constructed in Westphalia by the Markische Maschinenbau Anstalt, Ludwig Stuckenholz A-G. The method of working these protective appliances is such that when the grippers or jaws are opened the magnet is lowered automatically in order to raise the objects desired; the grippers or jaws then close beneath the magnet with the result that the dropping of the rails, channel bars, or angles is out of the question. It is maintained that these grippers, while serving as a protection, also effect a saving of current. When the magnet drops the objects into the grippers they continue the transportation of the material; thus the current is used only during the short period of lifting.

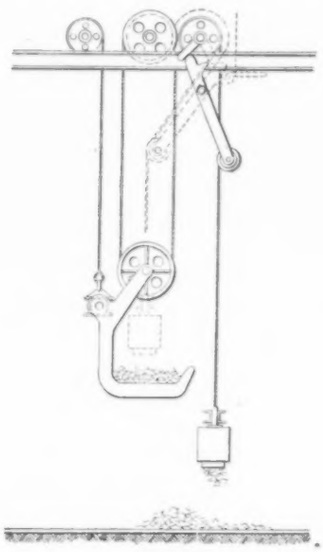


FIG. 4. GERMAN LIFTING MAGNET FOR ANGLES OR RAILS

For transporting rails, a crane-lifting magnet system is in use at Lear, near Ruhrort, in the iron and steel plant of the Actiengesellschaft, Phœnix, similar to that shown in drawings Figs. 1 to 4. There are two cranes, each having a span of 144 feet and fitted with two magnets. They transport rails and angles to the cars for loading, eight rails or more being raised and carried at a time. At this plant

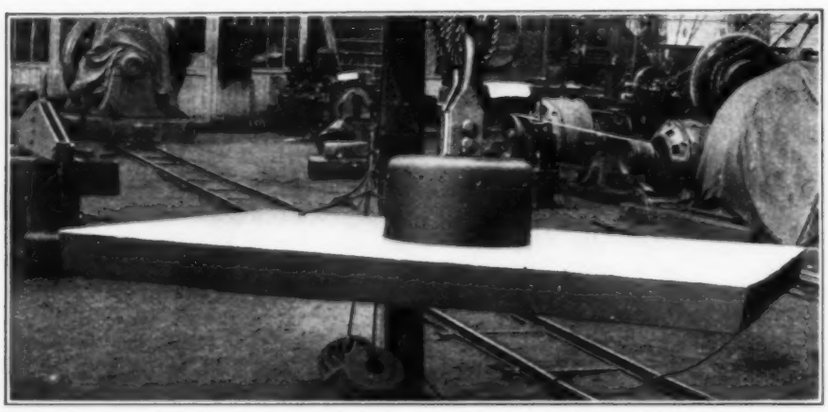


FIG. 5. ELECTRO-MAGNET IN A BELGIAN ELECTRICAL WORKS

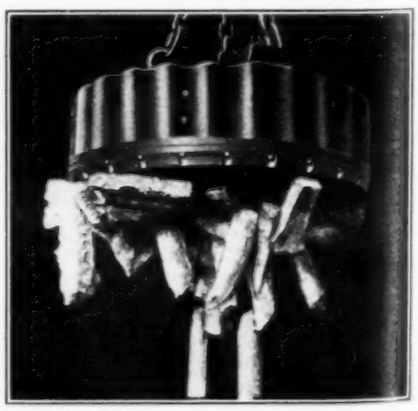


FIG. 6. ELECTRO-MAGNET LIFTING JIGS

a series of tests were made to compare lifting magnets with other transporting appliances such as chains, curved arms and other apparatus. It is maintained that the lifting magnets gave the most favorable service; not only as to cost of operation, but reliability as well. Fig. 5 shows the construction of a Belgian lifting magnet raising a weight by an over-

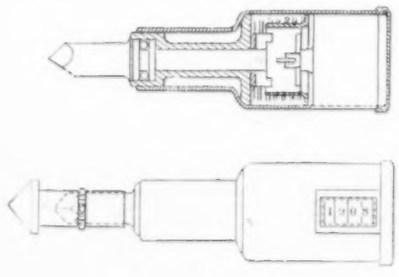
FIG. 7. TEN-INCH CIRCULAR MAGNET LIFTING BOILER HEADS

head crane. This was at the Liege shops of the Compagnie Internationale D'Electricite. The illustrations, Figs. 6 and 7, show two types of American electro-magnets in operation at the Donora works of the Carnegie Steel Company. The magnet in Fig. 6 is lifting 32 steel manganese-iron pigs averaging 65 pounds each in weight, thus making a total lift of 2080 pounds.

Fig. 7 shows a 10-inch circular magnet for light materials. It is in use lifting three boiler-head plates, each having a diameter of 36 inches and a thickness of ⅜ inch. The capacity is about ½ ton.

A New Speed Indicator

The speed indicator shown is entirely different in form from those generally



A NEW SPEED INDICATOR

used, as it has no dial or hands to be watched.

This is made by the Veeder Manufacturing Company, Hartford, Conn., on the same plan as their cyclometers and works in exactly the same way. The spring holds the wing clutch out of contact until the spindle is pressed against the end of the revolving shaft hard enough to engage the clutch and drive the number wheels which form the gear train. The total length is 3⅛ inches without the rubber cap and the largest diameter is 15/16 of an inch.

The thrust is taken by the ball bearing shown. This instrument reads up to 9999 and all that is necessary is to note the reading before applying. Wait till the second hand comes to a convenient point and then note the reading at the end of a minute or any fraction used. Then add or subtract and get the revolutions during that time. This allows readings to be taken in either direction.

Expanding Tool for Drill Press

By C. B. Kirkham

The tool illustrated herewith by Figs. 1 and 2, is an expanding or undercutting tool for use in drill press, and which has such distinct advantages over any which

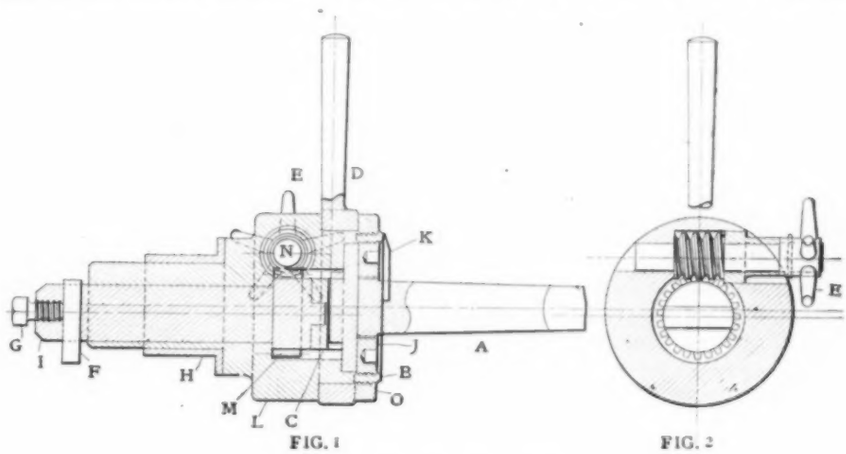


FIG. 1 FIG. 2

EXPANDING TOOL FOR DRILL PRESS

the writer has ever come across, that I believe it will be of some use to other readers.

In our line of manufacture, we have a very large number of gasolene automobile cylinders to machine. These are first bored and faced in a heavy fixture on a horizontal-boring machine, and then they are put into a box jig, and all holes are finished at one setting on a drill press. In order to do this, it was necessary to devise some kind of expanding tool to finish a chamber and also the relief to allow the tap to go through.

During the last three years, I have tried nearly all the types shown in your columns, and several of our own design, but with no great success, until the toolmaker and I designed this one.

As shown by Fig. 1, *L* is a machine-steel body with the bearing hole for part *I* offset from center *L*, equal to one-half the desired amount of expansion. The offset in this case, being ⅛ inch, giving an expansion of ¼ inch.

Fig. 1 shows the tool in the expanded position and it will be clear, that rotating the body *L* one-half revolution, will contract the tool, while the further rotation of one-half revolution will again expand it.

Part 1 is made of tool steel, hardened and ground, and is made with a square hole, as shown, to take a piece of 5/16-inch square Novo steel *F*, which is held into place by a set screw *G* in end of *I*. At the other end of *I*, there is an integral worm wheel *N* with 22 teeth, 16 pitch with a standard involute gear cutter; the teeth, of course, being cut at an angle to correspond with the lead on worm *N*, to which is pinned the star wheel *E* with five points, by means of which, the body *L* is rotated around the part *I*.

A is a shank made to fit a No. 3 Morse taper hole in drill-press spindle, and is made with a large flange at bottom, which is a working fit in body *L*, being held in place by the nut *J* which also takes up any wear. There is also an Oldham coupling at *C* by which the driving strain is transmitted directly from *A* to *I*, this joint allowing *I* to be moved in any position, by the eccentricity of the hole in *L*. This coupling relieves the worm wheel *N* from any strain, and also makes the tool much more rigid. *D* is the handle made fast to a collar which is a running fit on outside of body *L*. This is held in place and kept tight by the nut shown at *O*. When the operator takes hold of the handle one revolution of the drill-press spindle or of the tool, will rotate the worm wheel 1/5 revolution, as the arms of the star wheel *E* come in contact with the handle *D*, and as will be noted, the worm wheel being cut right hand, it will turn the body *L* backward 1/5 of the amount of one tooth, spacing on the worm wheel, which makes fifty-five revolutions for the extreme movement of the tool from minimum to maximum or *vice versa*.

The raised surface on body *B* is graduated to show the position of cutter *F*, the pointer *K* being for this purpose. *H*

is a tool-steel bushing to fit a corresponding bushing in jig cover from which all work is done on the valve ports.

The features of this tool are, that it is practically solid in use, there being no loose or delicate parts to be broken, and it can be expanded or contracted without stopping the machine, simply by holding the handle *D* from turning with tool.

When machining cylinders, the tool has to cut a chamber from a rough-cored hole, and the tool being narrower than the chamber, it is simply let down into the work, until a suitable distance piece between shoulder of the bushing *H* and jig bushing, gives the right position to the upper part of chamber. When the tool is expanded by holding the handle *D* and when to the required diameter, *D* is released, when the feed of the machine is thrown in, and the balance of the chamber cut out with the tool, the same as in ordinary counter-boring, the shoulder on *H* making a positive stop for tool. Stopping the handle, again contracts the tool ready for the next hole.

The Making of Dies for Canadian Coins

By W. L. McLaren

The first thing to be considered when a new coin is desired is the design. This is generally executed by some specialist in the field of art, and his efforts are handed over to a specialist in the steel-engraving line. This man works very slowly and with his files and cutters and engraver's tools engraves on the face of a piece of tool steel a likeness of the design as nearly perfect as human skill can attain unto. The product of this man's labors, after being hardened as hard as fire and water can make it with reasonable use, is ground and lapped to size all over except, of course, the face, and is what is called the "master die." From it the dies actually used in coining are struck in a manner which will doubtless surprise many who are not acquainted with the art.

Referring to Fig. 1, *A* is the master die and *B* a piece of tool steel (at room temperature) about two inches long and a little over an inch in diameter, beveled to a point at an angle of about 30 degrees from the horizontal; assuming that the dies are for striking quarters or shillings. The master die rests stationary upon the anvil and *B* is held by hand with a small pair of tongs, with its point on the center of *A* and its plane surface *K* parallel to the striking end of a crosshead actuated by the turning of a screw of huge proportions, which is in turn driven by a large, heavy fly-wheel lying in a horizontal plane, carried at the top end of the screw and firmly keyed to it. When raised to the top and released the weight of this wheel starts itself and the screw revolving, drives down the crosshead with such force that by the time it has lowered about eight inches anything placed in its path receives a squeeze of several tons. A friction disk running on the rim of the fly-wheel gives it added impetus when necessary. Thus it will be seen that as the piece *B* is held in the proper position below the crosshead of the press, something must give way when the usual blow of 40 tons is struck. Naturally the point is squeezed out over the raised portions of the master die for about one-half of the run of the tapered part; or the distance *X* of Fig. 1.

The piece now appears as in Fig. 2, with steel bulging out all around as at *S*. It is now put in a small crucible with three or four other similar pieces, covered well with charcoal and annealed. It next goes to a lathe where it is trued up as well as it can be with the portion already stamped. Then the bulge *S* is turned off and a fillet-shaped recess or groove is cut where *S* was, as at *R*, Fig. 3. The piece is again taken to the press and set on the master die; even a light pressure of the hand is sufficient to cause it to lock with the master so firmly as to require quite a pull to remove it. While it is locked the crosshead is allowed to descend very slowly, and the striking block is adjusted to bring down its surface on the next stroke in exactly the same position as at first. When all is ready the crosshead is run up by means of a friction disk similar to that already described, except that it is on the other side of the fly-wheel and another blow is struck.

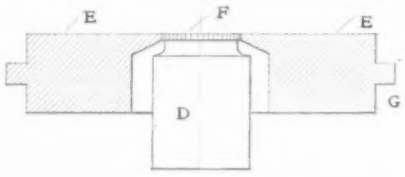
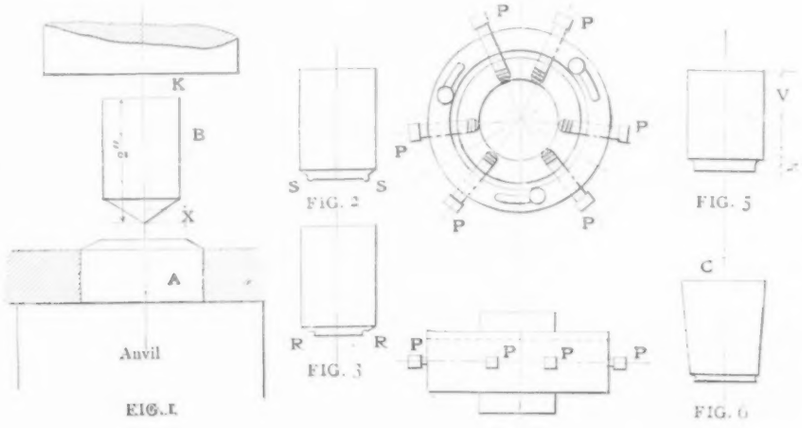


FIG. 7

COIN "MILLING" DIE FIG. 8

The frame of the press is so rigid that the crosshead, screw and fly-wheel rebound from the contact as if from a spring; the wheel even starts to revolve in the opposite direction. The second blow only causes *B* to flatten a little over half of the remaining amount desired. It is again annealed, the bulging steel is turned off and fillited; it is again set and then struck. This third blow generally finishes the work of the master on that particular coining die, although sometimes four are necessary.

The die *B* (for such it has now become) is placed in a ring chuck composed of a ring of machinery steel carrying six set-screws, set in pairs and staggered a little. Fig. 4 gives a general idea of the form of this chuck. The set-screws for holding the die are at *P*, while the holes and slots *Q* are for the bolts which hold the ring in place. The die is placed in the chuck face outward, is very carefully trued up to the outer edge of the stamped impression, the steel is turned back about one-fourth inch from this face, and the ring chuck, die and all are taken off and reversed. The shank *V*, Fig. 5, is turned true with the front end. It is now an easy matter to take it out and true up that portion where the set-screws gripped. The die is now packed in charcoal in a graphite crucible and the whole is heated to a good red heat in an oil furnace and kept there from 40 to 50 minutes. It is then removed and as quickly as possible plunged into cold water or brine. If necessary it is now ground and lapped, when it is ready to



A COINING DIE FOR CANADIAN COINS

strike a coin of the realm. No drawing of its hardness whatever is done.

The upper die invariably carries the impression of the head and is called the "obverse" die. The other or "tail" die is called the "reverse" and occupies the lower position, resting on the anvil. Its shank is straight while the obverse die has a tapered shank, as in Fig. 6. The reverse die is stationary except for an upward movement to eject the coin after it is struck. The obverse die is carried in the ram which strikes the blow and is adjustable as to position to bring the dies exactly one above the other. This adjustment is secured by grasping it in a cupped holder, fitted with three set-screws placed 120 degrees apart.

The popularly termed "milled" edge on the coin is produced by a piece of steel with a hole the exact diameter of a finished coin, with the proper indentations to produce the milled effect. This piece, Fig. 7, *E* is about 5 inches in diameter, with a tongue *G* all around by which it is held. The hole in its center fits closely over the neck of the reverse die and is held rigidly in position. The inner or milled edge is represented at *F*; *D* is the die. After each coin is struck, *D* pushes up just enough to clear it of every part of the surface *F*, and a carrier at the next instant takes it along and drops an unstamped one in its place. For years *E* was made wholly of tool steel, but so much trouble was experienced with warpage and breaking when hardening it is now made in two sections; *H*, Fig. 8, being made of machinery steel with the center *I* of tool steel fitted in with a taper of ¾ inch to the foot and under several tons preessure.

To strike a coin a pressure or blow of about 20 to 30 tons is exerted by the press at the instant of contact. Should no blank be fed (and this sometimes happens) the dies come together with a discouraging sound quite easily recognized by those in charge. Should another blank be struck by those dies the resulting coin cannot be used, for plainly discernible with a microscope are the features of the head on the tail side and *vice versa*.

Amalgams for the frictional parts of electric machines are combinations of quicksilver, tin and zinc, according to the *Engineer*. The quicksilver is heated to 302 to 392 degrees Fahrenheit, transferred to a wooden box, the melted tin and zinc added to it, the box closed by a lid and mixed by vigorous shaking. The proportions of the mixture, according to Singer, are (a) six parts of quicksilver, two parts tin, one part zinc; (b) seven parts quicksilver, four parts zinc, two parts tin; various other proportions of these ingredients are sometimes used.

It is reported that the first plant on this continent for the electric reduction of zinc will be completed and ready for operation the early part of next year.

Automobile Cylinder Boring and Facing

The tools furnished by Bardons & Oliver, Cleveland, O., to the Stevens-Duryea Company, of Chicopee, Mass., and illustrated herewith, make an interesting addition to this class of tools. They are for boring and facing automobile cylinders and are used in one of the turret lathes made by the same company.

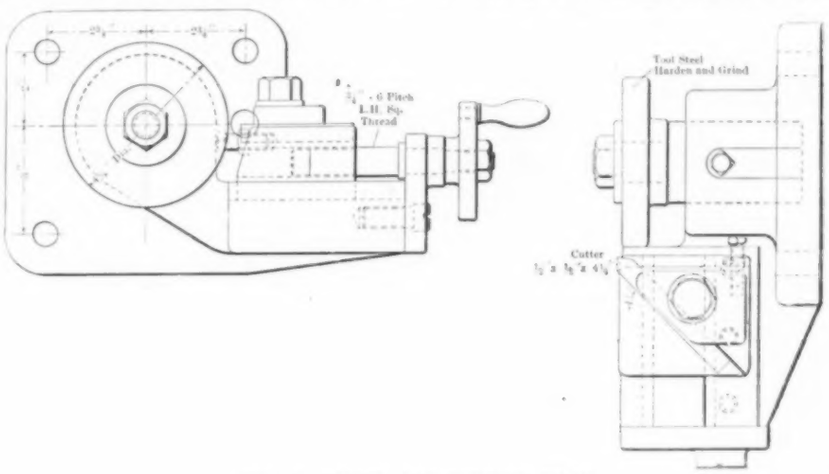


FIG. 2. FACING AND TURNING TOOLS

Only the finishing bar is shown in Fig. 1, but it illustrates the principle employed. An arm *D* of stiff section is cast solid with a square base, which bolts solidly to the face of the turret. On the side of this the arm *E* is pivoted at *F*. This carries the tool *T*, fastened by the set-screw at the side and set up to its work by the screw *A*. The other end is controlled by the screw *C*, with a suitable handle for turning it. The set-screw *B*, held in place by the lock nut shown, is the stop which determines the size of the cylinder bore. The arm *E* is raised until it rests solidly against stop *B* for the finishing cut; then, after the cutter breaks through into the counterbore (which is left rough from the coring in the casting) the screw-cutting tool is raised away from the cylinder wall so as to avoid the mark which would be left by drawing it back without this precaution.

After the cylinders are bored the outside facing and turning tool shown in Fig. 2 comes into play. This also bolts to the turret face and carries a tool-steel roller which is hardened and ground to fit the cylinder bore and supports the outer end for the facing cut. This roller is free to turn on the stud which carries it and this whole element can be easily removed at any time for repair or replacement with a different size.

The facing and turning cutter is held in a small cross-slide and controlled by the ¾-inch, 6-pitch screw, operated by the handle shown. The cross-slide stops against the central position through the set-screw and lock-nut indicated in both views.

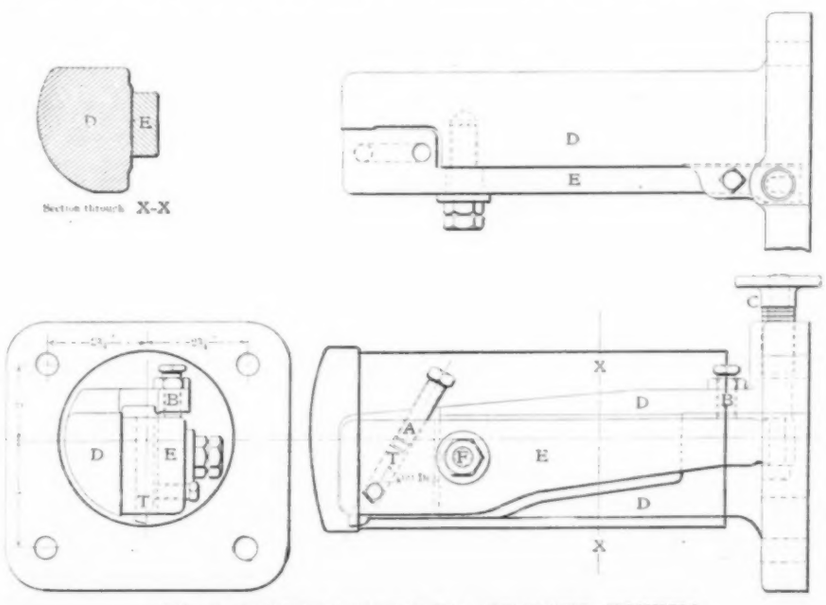


FIG. 1. FINISH BORING BAR FOR AUTOMOBILE CYLINDERS

Vanadium in Steel Castings

The Properties Given to Steel Castings by Addition of Vanadium with Some of the Tests Made and How It Is Added to the Metal

BY E. F. LAKE

Vanadium having been proved such a valuable alloy for steel, it has been taken up by the Union Steel Castings Company, of Pittsburg, Penn., which has experimented with it for some time in steel castings. The results of these experiments were so satisfactory that it has been adopted as a regular product of the foundry.

This is a comparatively new use for vanadium, as it is added to the composition that is used for ordinary steel castings, whereas in the rolled steels it seems to give the best results in what is termed the quartering alloys, such as carbon-manganese-chronium-vanadium or the carbon-manganese-nickel-vanadium steels. The results obtained from these castings would go to prove that it gives desirable properties to nearly any of the steel alloys by making a more homogeneous steel and one that will withstand alternating vibrations to the extent of three times that of the ordinary steel casting. At the same time it raises the figures in the ultimate strength and elastic limit which are obtained on the pulling machine.

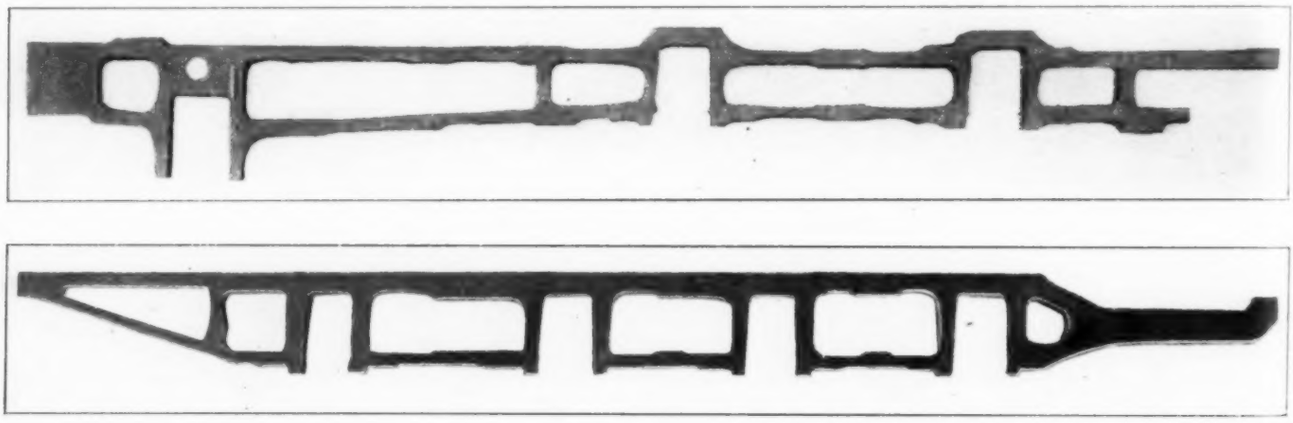
This vanadium steel also produces castings that are as easily forged and welded as the ordinary steels, so that the castings can easily be forged at any desired places into shapes which are too difficult to make in the casting; or two or more castings may be welded together in order to obtain shapes which are too intricate to cast without an excessive labor cost.

Locomotive Side Frames

The addition of vanadium to ordinary steel for castings has much more than doubled and in many cases more than trebled the breaking strength of the locomotive side frames which are being cast by this steel foundry for several different railroad companies.

Marks.	Elastic Limit, Lb. Per Sq. In.	Ultimate Strength, Lb. Per Sq. In.	Percentage of Elongation in 8 Inches.	Alternating Vibrations.
ORDINARY STEEL.				
1—O.	36.130	68.870	20.0	4.707
2—O.	36.450	68.230	20.0	3.706
VANADIUM STEEL.				
1—V.	46.450	77.160	20.0	14.971
2—V.	44.790	78.440	23.0	10.582

Two of these side frames are shown in the half-tones, and a third is shown in the line cut in order to give an idea of the dimensions.



FIGS. 1 AND 2. LOCOMOTIVE SIDE FRAMES CAST IN VANADIUM STEEL

In Fig. 1 is seen a side frame for the Atlantic type of passenger locomotives, which weighs about 4500 pounds. Fig. 2 shows a side frame for a similar type of engine, but longer, as two more driving wheels are used. Its weight is consequently increased to about 5200 pounds. Fig. 3 shows a line cut, with the dimensions of the Consolidated type of freight locomotive, which weighs about 5600 pounds.

The Union Steel Castings Company uses the open-hearth furnace for melting its steel, and the vanadium is added to the mixture just before tapping. The slag is raked from the top of the molten metal, the ferro-vanadium thrown in and the whole allowed to stand a few minutes, so that the vanadium will thoroughly mix with the metal. The furnace is then tapped and the molds poured.

Tests and Analyses

Comparative tests were made with a round test bar 5/8 inch in diameter, of the ordinary steel as used in castings and the same steel after the vanadium had been added, with the following results:

The test bars were taken from the same heat that went into locomotive side frames such as are shown in Figs. 1, 2 and 3. The pulling tests were made from the long end of the bar that was broken in the vibrational testing machine.

It is in the vibrational stresses that vanadium shows its great superiority, and these tests were made on an alternating bending machine by gripping the test bar rigidly at one end and bending the free end upward and downward 1/8 inch from its axis. It gave a total length of stroke of 1/4 inch, and this at the rate of about 30 strokes per minute.

The test bars used in these tests were afterward analyzed with the following results:

ORDINARY STEEL	Per cent.
Carbon	0.27
Manganese	0.57
Silicon	0.26
Phosphorus	0.048
Sulphur	0.033

VANADIUM STEEL	Per cent.
Carbon	0.28
Manganese	0.57
Silicon	0.28
Vanadium	0.217
Phosphorus	0.042
Sulphur	0.036

Thus it will be seen that the two metals were so nearly alike in their composition, other than the vanadium, that it must

have been this product that caused their great differences in strength, especially their ability to withstand vibrational stresses, which is a great factor in locomotive side frames or parts and in any other machine parts which have to withstand similar strains and stresses.

Heat No. 6526, which was poured the day before my visit to the plant, showed on analysis that it was composed of:

	Per cent.
Carbon	0.26
Manganese	0.555
Silicon	0.29
Vanadium	0.20
Phosphorus	0.047
Sulphur	0.036

This heat gave the following strengths when pulled: Elastic limit, 41,720 pounds per square inch; tensile strength, 73,800 pounds per square inch; elongation, 32 per cent. in 2 inches; reduction of area, 55.8 per cent.

Other Tests

Many crude tests were given the steel in the foundry. One was to count the number of blows given the test bar to break it off; for instance, their ordinary steel, which was a good quality, required 10 blows with a 10-pound sledge to break it off, while the test bar on the vanadium steel required 137 blows by the same man with the same 10-pound sledge.

A ½x1-inch bar of vanadium steel was bent flat upon itself without a crack developing, while the ordinary steel bar of the same size cracked at the last blow.

Another test was to take two ½x1-inch bars, one of ordinary steel and the other of vanadium steel, bend them to an angle of 90 degrees, then straighten them and bend them the opposite way 90 degrees.

The result of this was that the ordinary steel bent twice to 90 degrees and the third time to about 75 degrees, when it broke; while the vanadium bar bent four times to 90 degrees, breaking on the fourth bend, thus showing about 30 per cent. better bending qualities than the ordinary steel.

A bar that gave a tensile strength of 82,183 pounds was cut in two, welded together again and then pulled, giving a tensile strength of 72,460 pounds, which showed an efficiency at the weld of 88 per cent.

Mixing the Metal

Before adding the vanadium in the furnace it is necessary to have the oxides all removed from the metal, as the vanadium has a great affinity for oxygen. If any of the oxides remain in the metal, the vanadium will scavenge them out and go off in the slag, owing to its great elusiveness; but as vanadium is too expensive to use as a scavenger, the oxides should be removed before it is added to the steel.

Many failures in the use of vanadium in the past have been due to this elusiveness or its affinity for oxygen, as many thought that if they put the vanadium in the steel, it must be there after pouring. As a matter of fact, it might have oxidized out or physicked through the metal and not given it any of the desirable properties it is capable of.

With the oxides removed and other necessary precautions taken, the vanadium can be added a few minutes before tapping, which practically accompanies the addition of the silicon, with an assurance that it will be in the metal on analysis; or more correctly speaking, that 90 per cent. of it will show in the metal on analysis, as by having the steel right first, then adding the vanadium properly and at the right time, a loss of more than 10 per cent. in the melting is uncalled for.

Pouring the Molds

The foundry also seemed pleased with the way the metal poured, as they said it poured excellently. The working of the steel in the furnace, the ladle and the molds was as good an any they ever had, and the results they got so far as solidity was concerned, were a great deal better than the average.

A piece of vanadium steel which they showed me was turned from the solid and did not show an imperfection in it. Of a number of locomotives side frames which they had cast, not a single one had to be patched or repaired in any manner before using.

The cost of the vanadium-steel castings is nearly double that of ordinary steel castings; or to be more specific, with ordinary steel castings selling at 4 cents per pound, vanadium-steel castings would have to bring 7 cents per pound, owing to a number of causes.

The cost of the vanadium alloy on vanadium content is $5 per pound; that is, if a ferro-vanadium contained 25 per cent. of vanadium, it would cost one-quarter of $5, or $1.25 per pound. This sounds large; but when we stop to consider that but about one-fifth of 1 per cent. vanadium is alloyed with the steel, this does not seem so alarming. Extremely small doses are sufficient to give the desired results.

Then again the steel turned into castings is only about 60 per cent. of that in which the vanadium is alloyed, as 40 per cent. goes back to the furnace in the form of risers, gates, sprues, etc. In these the vanadium is lost, as it always oxidizes out on being remelted and the scrap is worth no more than the ordinary steel scrap. All it is good for is to melt and add the vanadium over again.

If the castings are properly annealed after being cast, the vanadium-steel castings are more easily machined. This in itself is quite an item, as one locomotive builder has had to pay nearly twice as much for machining side frames as it would cost to machine the ordinary carbon steel.

The uses to which vanadium-steel castings can be put, giving a longer life or wearing quality to the parts, are very numerous, including such tools as rock drills, pneumatic chipping chisels, rock- and ore-crusher parts and in fact all tools or machines which are subjected to vibrational strains.

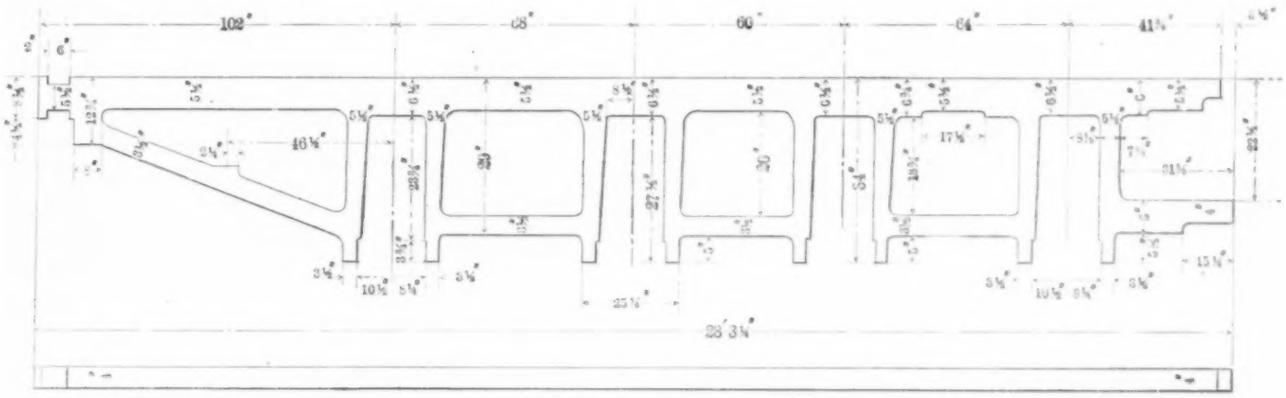


FIG. 3. DIMENSIONS OF LOCOMOTIVE SIDE FRAME CAST IN VANADIUM STEEL

Thirty parts of plaster of paris, ten parts of iron filings and one part of sal-ammoniac, mixed with vinegar to a fluid state, forms a cement which is said to give good results for fastening iron to marble. As the mixture hardens quickly, it must be prepared for immediate use.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Cutting V-Threads with the Compound Rest

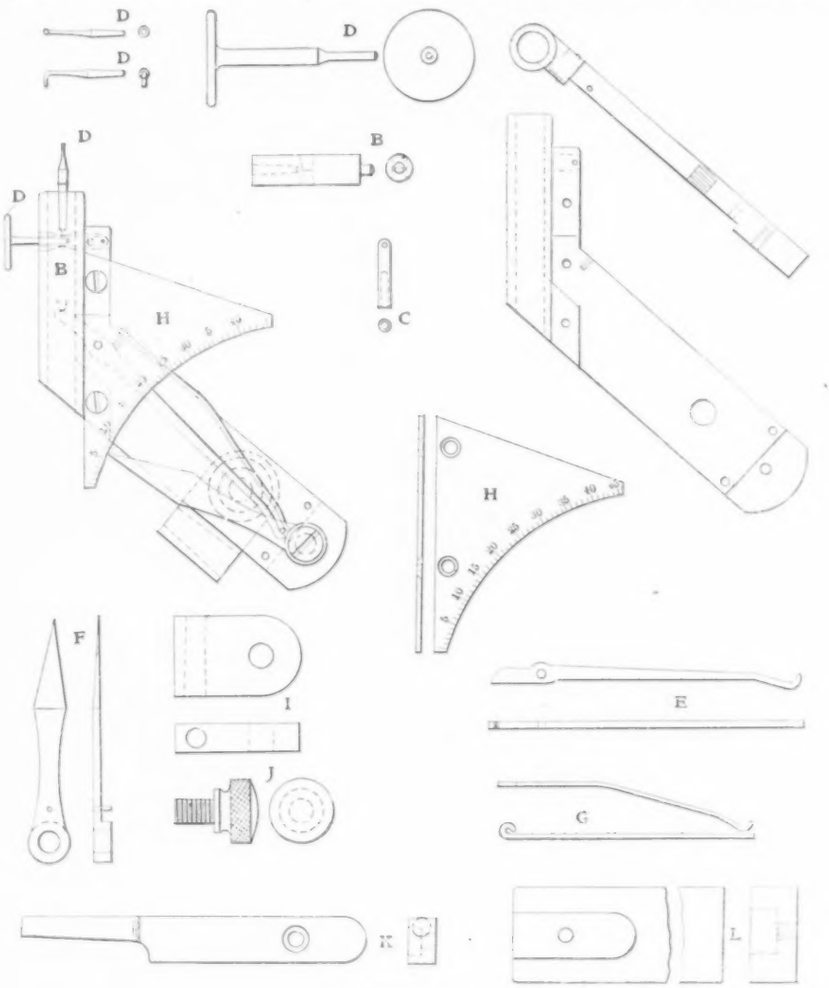
In view of the present interest in this method of cutting V-threads, I may mention that I wrote an article on the subject for the AMERICAN MACHINIST, which was published in the issue of July 31, 1890, nearly eighteen years ago. The work that prompted this article was on a lot of screw-machine spindles. These spindles were 2½ inches diameter, cut 4-P, at the nose end. Besides having to be very true and smooth, these threads had to fit perfectly a threaded ring gage so that all would be interchangeable. To make the matter difficult, the spindles were a peculiar kind of forging, very tough and liable to tear when finishing the thread. To have a thread tear on a finishing cut meant the loss of the spindle and all work previously done on it. As I now remember, this plan was original with me at the time. I used two tools on this work, one to cut down with and finish the front side of the thread, and then changed tools for a side-cutting tool, to finish down the other side. Neither of these tools were ground to 60-degree angle, but a few degrees less, and the correct angle of thread was obtained by the setting of the tools, together with the compound rest. By using two tools in this way, a proper top rake on each is allowable, which helps greatly toward rapid and smooth cutting on tough stock.

J. T. SLOCOMB.

Providence, R. I.

A Test Indicator

This multiplying gage and indicator is simple in construction and very sensitive. The body *A* is cast of gun metal. A ¼-inch hole is drilled and reamed through the upper end to a snug fit for the plug holder *B*. In the middle of this plug-holder is a crosswise hole taper reamed from each side to receive another plug-holder *C*. Both plug-holders *B* and *C* are drilled from end and taper reamed to the same size to fit different styles of indicator plugs *D D D D D*. These can be made in various shapes and lengths to accommodate the job. The other end of plug-holder *B* is rounded almost to a sharp point so as to give it a small bearing surface on the lever *E*. The closed end of plug-holder *C* is pivoted on a pin in the hole in *A* to give it a swinging motion. The lever *E* also swings on a pin fastened in holder *A*. The other end is shaped to the arc of a circle so the pin in the indicator lever *F* will ride freely to and fro. Lever *F* swings on a shoulder screw with a stop pin at each side. Against the side of the lever *E* presses a bent piano wire spring *G* held with a flat-head screw at the opposite end. On top of holder *A* is fastened with two flat-head screws a white ebony plate *H* which is graduated by fastening a micrometer head in front of the indicator point and laying off the divisions in thousandths on the plate. The graduations and figures are black so as to be read very clearly. Under the holder *A* is a tool-post arm *I* which swings in either direction and is clamped with a nurled-head screw *J* when set in position. On one end of arm *I* is drilled and taper reamed a hole to fit the taper end of tool-post holder *K*, which is made small enough to allow it to enter a bench lathe tool-post, and at the same time it fits in one end of the large tool-post holder *L*, where it can be clamped securely with one screw and used in an engine lathe. As shown in the assembled view, a contact plug *D* is used at the left side to indicate inside work such as holes and slots when truing up revolving work in a lathe, but in order to have the graduations register correctly in thousandths the distance indicator plug *D* projects must be only ½ inch. The front end indicates outside work. By merely fastening the tool-post arm *I* on a surface-gage rod with a taper at the end to fit the hole in *I*, this instrument can be used as a step or hight gage for measuring from surface to surface and for many other purposes.



TEST INDICATOR

R. A. ALMOND.

New Britain, Conn.

Why Planers are Bolted Down

Referring to the discussion going on in your columns as to why planers are bolted down, I would like to contribute from the experiences of a firm in Nashua, N. H., builders of planers, etc. They find more or less trouble with planers sliding along on their foundations, the sizes 36-inch and larger giving more trouble than the smaller ones. The difficulty seems to be occasioned by the varying pressure put upon the gearing by the impact of the tool in starting the cut, in plowing through irregularities in the rough castings and the sudden release at the end of the cut, these causes all keeping up a jarring sufficient to cause the bed to work along on its foundations and the great weight of the castings being machined add to the momentum.

This firm has overcome the trouble in the way shown in the cuts, the custom being to make a wooden frame of the hight necessary to raise the machine to its proper hight above the foundation proper and to pour the frame full of grouting (concrete), and when this has hardened sufficiently lay on the leveling blocks shown in Fig. 1. Those for the ends of the bed are webbed to sink into the cement and openings are provided through which cement may be poured after the plates are in position. When the bed is lowered in place the set-screws are run out to the ends of the bed and the check-nuts tightened. The small blocks are bedded into the soft grouting and left to set.

When all is in position, all that is necessary to secure proper alinement of the machine is to draw the top blocks up with the screws provided for that purpose.

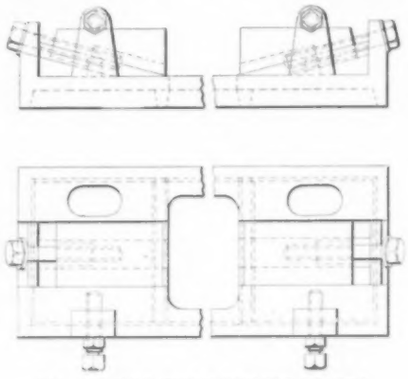


FIG. 1. THE END LEVELING BLOCKS

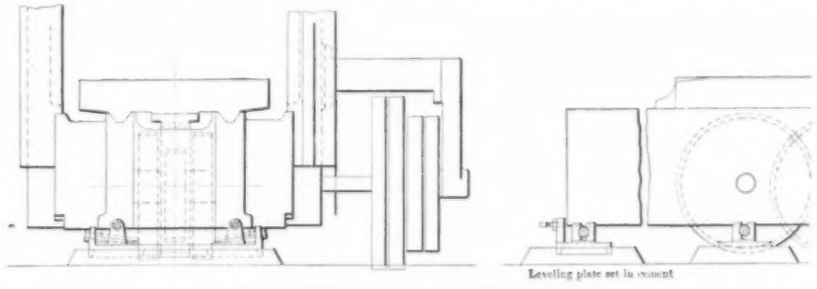


FIG. 2. THE LEVELING BLOCKS IN PLACE

Fig. 2, showing sections of the bed, is taken from one of the foundation drawings furnished with the planers.

I have known of men who were gray with shop experience who thought that because a planer bed was of massive proportions and well braced that it should bear almost any weight which could be placed upon it, and be put upon the most indifferent foundation and still give best results. A case in point which came to my notice recently is as follows:

A helper took advantage of the space between a 42-inch planer bed and a post, when the table was on the return, to run in a truck loaded with a stiff, heavy casting, hoping to get by before the table came back, but he was too slow and the table pushed the casting against the post, which proved to be a strong one, and the planer was pushed along bodily on its foundation for about two feet. The most exasperating part came when the foreman had the machine pushed back into place, without any attempt at leveling it up, and then entered complaint at headquarters that the machine was badly out of true.

On investigation by the manufacturers, the above were found to be the facts in the case and steps were taken to have the planer properly leveled up, after which there was no further complaint. I do not know what would have happened if the planer had been bolted down.

The above incident happened to a machine in a shop under control of one of the large departments of our Government.

C. A. HEALD.

Nashua, N. H.

During the past ten years I have set up machines and engines for shop and rolling-mill work. At first I thought I had very good results from fillings I was told to use, but later on I found they were all wrong.

A few years ago I was working as machinist in one the well known tool-builders' plants and they wished to put up a new horizontal drill. I was given the job of setting it up and was told by the foreman to use lead for the filler after the machine had been lined up on the small wedges around the bottom. I said nothing, but went to work and in a short time had everything ready for the filler when along comes about 150 pounds of lead to be melted and poured in. I went to the foreman then and asked why he wished lead to be used instead of something better. He said he had very good results from it; I asked to see some of the results and he took me over to one of their large planers and said this was filled with lead over two years ago and has not moved any. I got down and looked at it; I could see daylight in every direction and noticed that the machine was resting on the wedges and small plates and the bolts were used to draw it down solid. Of course the lead had shrunk and was of no use.

Now this planer was very slow on the cut and reverse speeds, and there was very little danger of it moving. But had it been a modern high-speed machine there would have been a great deal of trouble.

This is the formula: Take six buckets of fine gravel or coarse sand to one of good cement, use enough water to make a thick dough, then ram it under the machine tight. The water that is used is not enough to affect the filling.

If this is used correctly there is no need of bolts and no danger of the machine moving.

W. A. MITCHELL.

Sydney, Nova Scotia, Canada.

Stopping Chatter on Large Boring Heads

We do a large amount of boring with large cutter heads, and at one time had the experience that Mr. Green points out at page 175, namely, chatter caused by the head jumping. This objectionable feature was overcome by unevenly spacing the cutters so that the distances between are all different and no two cutters come diametrically opposite. This uneven spacing of the cutters prevents them jumping into, and thereby deepening, any "rut" that may be momentarily formed by preceding cutters. I am inclined to think that with a head having cutters inserted at slightly different angles, there is a tendency to chatter when entering the work which is likely to continue until the head has entered sufficiently for the difference in cutter inclination to make itself felt by presenting the cutters at differently spaced intervals (which is the condition as the rear of the head is reached). However, the two systems are similar in their aim at "rut-dodging," but I think our method has the advantage of economy in the process of shaping the grooves. During this operation the centers between which the cutter head is mounted may be fixed for a universal angle, and the uneven spacing attained by varying the amount the head is revolved for cutting each groove.

W. J. CHAMBERS.

Manchester, England.

English vs. American Lathe Beds

In the article, "Good and Bad Points on Machine-tool Design," by Mercury, on page 621, Vol. 30, part 2, I fail to see the great advantage which he claims for the American bed compared with the English bed. Take, for example, two recent designs of English and American bed, considering the front shear and saddle only.

Fig. 1 shows 7½ inches center English; Fig. 2, 7½ inches center American lathe, both drawn to the same scale. The length of the saddle in the English lathe is 18½ inches, in the American 17 inches.

Comparing the Bearing Surfaces

The surface resisting the downward thrust in the English is 32 square inches against 17 square inches in the American. The surface resisting the side thrust or the thrust of the saddle against the side of the box is 13.8 square inches in the English and 8.5 square inches in the American.

Mercury begins here, taking the side thrust of the English bed and compares it with the downward thrust of the American, thereby claiming the advantage of the American over the English bed. How Mercury has converted the side thrust of the tool, or I should term it the *back* thrust of the tool, in the English lathe into a downward thrust in the American lathe is a mystery to me. Of course the downward thrust of the American lathe, and therefore the downward wear, will be central with shear or guide and will alter the diameter of the shaft being turned but slightly; but this also applies to the English bed. The side thrust on the English bed, which Mercury makes such a point of and which alters the diameter of the shaft being turned by just double the amount of wear, also applies to the American bed. The side thrust or wear on the American bed cannot be converted into a downward wear. Consider that the downward thrust is about 2.5 times the side thrust and that half the downward thrust and the whole of the side thrust of the American bed are taken on the same surface (about 8.5 square inches), while the English lathe has a surface for each thrust altogether about 45.8 square inches. Taking, for the sake of comparison, that the thrust area is proportional to the wear, the American bed will have 1.6 times the side wear and nearly double the downward wear of the English bed. Therefore as regards wear and alinement, the English form of bed has undoubtedly the advantage over the American bed. Under heavy cuts the pressure of the saddle is better distributed over the bed, owing to the difference of bearing area.

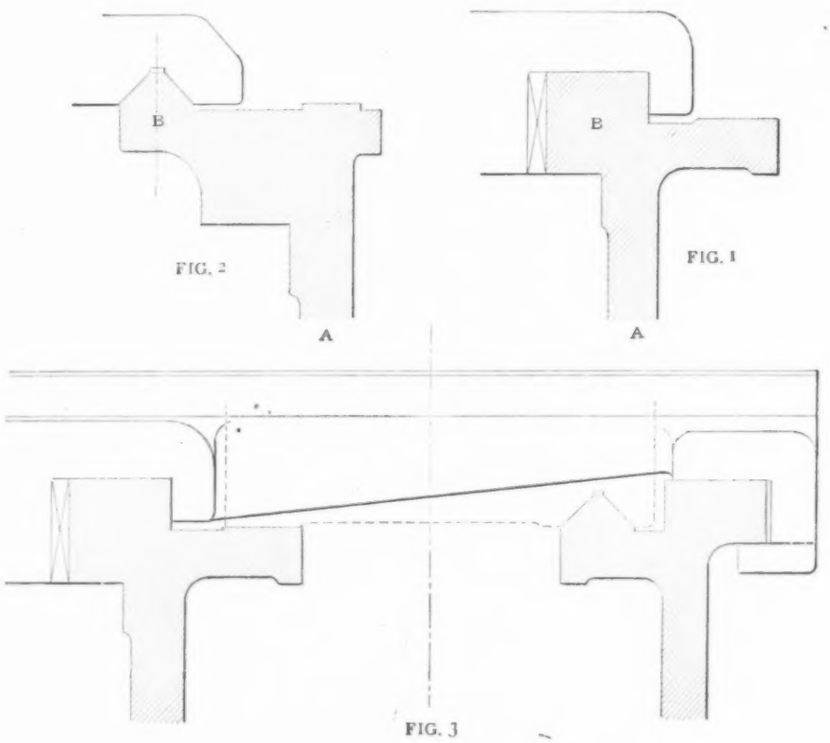
Mercury also writes, "Another great point is that the chips fall off instead of getting under the saddle, as they have such a tendency to do on the square bed." The bed could never have been scraped in an English shop if the chips which roll or fall off the inverted V could get under the saddle. No, it is not the ordinary chips that do the damage; it is the very small chips, cast-iron dust and filings which fall onto the bed and are held by the film of oil, as for instance after filing a pulley or wheel. Unless this is wiped off before moving the saddle, it will eventually get under the saddle and scratch the bed. The inverted V is not proof against this, as shown by the appearance of the V's on a lathe recently installed in the shop.

Loose Headstock Guide

As regards the guide for the loose headstock, I prefer the inverted V for the reason that the wear will be downward. The ordinary guide (between the shears) will have the same downward wear as the inverted V plus the side wear caused by continually moving the headstock up and down on a surface which is not wiped as often as it should be. For example, suppose the wear to be 0.0025 inch on each side; then it is possible to set the headstock to vary the diameter of the work 0.0300 inch, or, for every thousandth of an inch wear on each side of the guide you can vary the work 12 thousandths of an inch, with the spindle projecting about one inch from the headstock. This does not seem possible, but sketch it out and prove for yourself. As mentioned before, I prefer the inverted-V guide for the above reason and offer as my idea of the best form of bed, Fig. 3. The saddle is shown by full lines and the loose headstock by dotted lines.

The reason why the English manufacturer clings so lovingly to the square bed is because he has not been convinced of the advantages of the inverted V.

Yorkshire, England. F. Pike.



ENGLISH VS. AMERICAN LATHE BEDS

Breaking up Long Curly Chips

In the article on automatic screw-machine turning tools at page 209, mention is made of the curly chips being troublesome. They are also troublesome at times when doing slide-rest turning on the bench lathe, and I frequently break them up by momentarily stopping the feed. This is an absolutely dead sure way of causing a curly chip to come to an end, and the feed does not have to be interrupted so very long either—only long enough to allow the work spindle to make at least one complete turn. I have used the same scheme when drilling chucked work, by giving the tail-spindle screw an intermittent motion. I should think this result might be accomplished on an automatic screw machine by giving the cams the proper shape, or even filing a few slight dents in existing cams, but this latter device would have a tendency to make the beginning of the next instalment of the chip a trifle heavy.

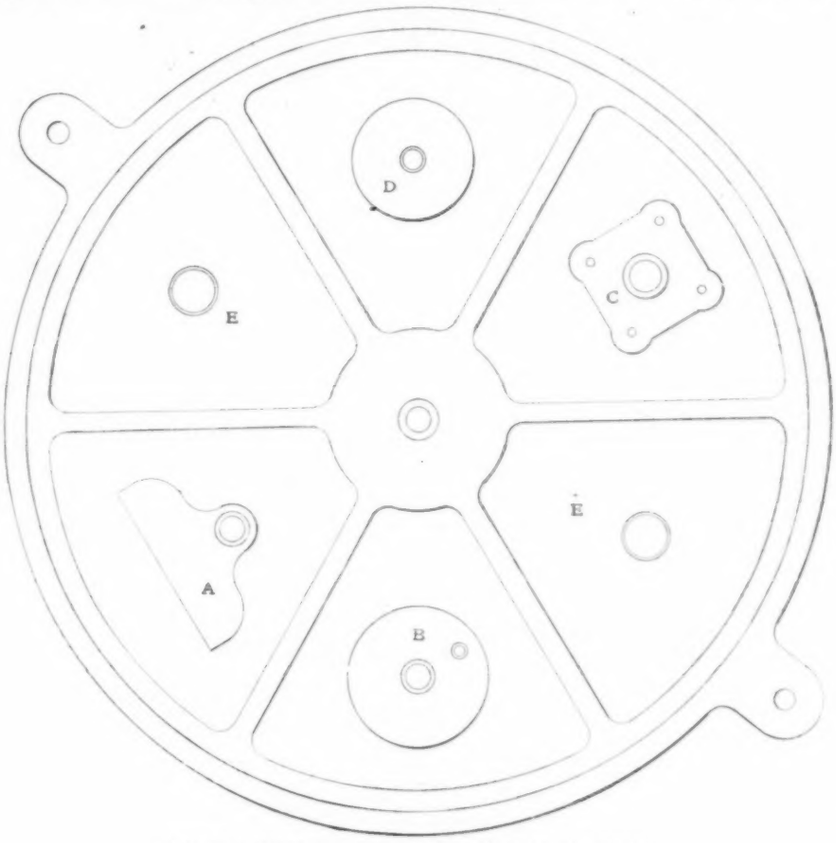
Brooklyn, N. Y. Walter Gribben.

Molding a Mower Wheel

I was very much interested in C. G. Campbell's article on page 906, Vol. 30, Part 2, in regard to molding machines, having had occasion to build several machines of this type. I departed somewhat from his methods; and thinking it might be of interest to some, I will endeavor to explain my plan, which I consider more economical.

The line cut represents the top view of a stripping plate for a mower wheel having six spokes. The pattern is dropped and the drawing simply shows the outline and the core prints.

The stools between the spokes are made separate and mounted on posts which are screwed into the bed of the machine. After the wheel pattern has been mounted and the stools fitted between the spokes, I select four patterns, of which we need the same number of castings as we need of the wheel. Care should be taken in selecting these patterns, that they are easy to draw and do not have too many core prints.



MOWER WHEEL FITTED UP FOR MOLDING MACHINE

Using the stools as stripping plates, I mount patterns at *A*, *B*, *C* and *D*. These are fastened to the same frame as the wheel, and of course draw when wheel does.

A is a frame bracket. *B* is a pitman crank disk. These patterns are partly in the cope and partly in the nowel. *C* is a pipe flange and *D* is a face cam. These last two mold in one-half of the flask, except their core prints. *E* and *E* have no patterns, as the sprues are located here.

After one-half of the machine has been fitted up each stool is taken out and dowelled face to face to the corresponding stool for the other half of the machine. They are then marked and fitted to be identical with the stools in the first half of the machine. This insures a perfect match on the wheel as well as on the smaller patterns.

These machines are mounted on low trucks and the nowel half is provided with two pivots, by which the machine can be lifted with an air-hoist, swung bottom side up and lowered to the floor. The flask is then released and the machine raised. This prevents any danger of losing a mold by the sands falling out.

Now suppose our molders put up one hundred flasks a day; we have also four hundred other castings which have not cost us much more than it did Mr. Campbell to put blocks between the spokes.

Auburn, N. Y. A. D. MUNDY.

Lattice-bar Punch and Die

Replying to Mr. Charlton's query at the end of his article on the above subject at page 401 would say: The probable reason why the punch cracked was because it was quenched face down. It is, of course, impossible from the meager data to give a positive reason, but experience with similar punches has taught me that they will crack if quenched face down. The best results were obtained by dipping at an angle with one of the thick parts of the face touching the water first. By dipping face down the thin center is dead hard before the heavy sides are cool and when they cool they pull the center apart, or if they do not the strains are there, and later on when in use will show up in the form of a crack. Let him try quenching in this way on the next lot of punches.

New York. E. A. DIXIE.

Grinding with Beveled Side of Wheel

At pages 248 and 249 I notice some criticisms on my method of grinding formed cutters on the beveled side of the wheel, Mr. Williams may be in the habit of grinding his cutters by laying them flat on a horizontal plate mounted in front of the wheel. This method will answer fairly well on such work as gear cutters, etc., but in his roughing-out process as soon as the tooth is ground to fit the curved shape of the wheel he would have approximately the same heating effect as though he had used the flat side.

In all cases I mount the cutter on an arbor supported between the centers on the grinder, passing the work back and forth past the emery wheel in the same manner as the teeth of a gear or reamer or similar piece of work is cut on a milling machine the beveled side of the emery wheel is adjusted radial with the cutter just the same as a gear cutter must be set central or reamer fluting cutter correctly set to produce a radial cutting edge on the reamer.

When the job is set up this way it does not matter whether the cutter is 1 inch thick or 1 foot thick, neither will a difference in diameter at the ends make any difference so long as the beveled side of the wheel is wider than the greatest depth of tooth being ground.

There will of course be unequal wear of the wheel and when much stock is to be removed the teeth should all be roughed out first and then the wheel should be trued up for the finishing just as any experienced grinder would do with any kind of a job where heavy roughing and finishing is to be done with the same wheel. For feeding the cutter up to the wheel it must of course be revolved on the centers in order to preserve the radial face of the tooth instead of moving the table of the machine or the wheel as some might do.

Mr. Quinn has evidently used a very soft wheel which would wear away faster near the center owing to the slower speed at this point, while the larger diameter of the wheel which would be cutting at the smallest diameter of the cutter would wear

the least and therefore would as he says grind that part of the tooth farthest back, or perhaps he has fed the cutter straight up to the wheel instead of revolving it for the feed as explained above. Either of these causes would have the same effect of grinding too much off of the smallest diameter of tooth.

In reply to Mr. Abbott I wish to say that each particle of emery in contact with the work is engaged in cutting a chip of metal from the work the same as a lathe or planer tool, each one taking a certain amount of pressure to hold it up to its work and each producing a certain amount of heat. In using the flat side of the wheel up to 8 inches long by 7 inches diameter. The larger ones varying in diameters on the same cutter from 2½ inches at some points to 7 inches at others and tests with the indicator showed them within 0.002 inch of flat and radial over the entire surface of each tooth.

Philadelphia, Penn. J. E. RAMOPON.

A Delicate Broaching Job

This machine was built for a company using a large number of brass plugs having a slot as in Fig. 1. These plugs vary in length from 1⅛ to 2 inches, and have ends; these serve to adjust the sliding part and to take the strain of the cut. *I* are the machine-steel racks, which run through the centers of castings *C*. *J* is a machine-steel angle bar holding the broach, which will be described later. The table *L* with spring and eccentric actuated vise *M* and broach-bar guide *V* all are screwed and doweled in position.

The broach guide is of cast iron with adjustable bronze guides on four sides of the broach bar. *O* is the driving shaft carrying two gears meshing with the racks *I*. *P* is the back gearing and *Q* the driving pulleys, one tight and two

FIG. 1

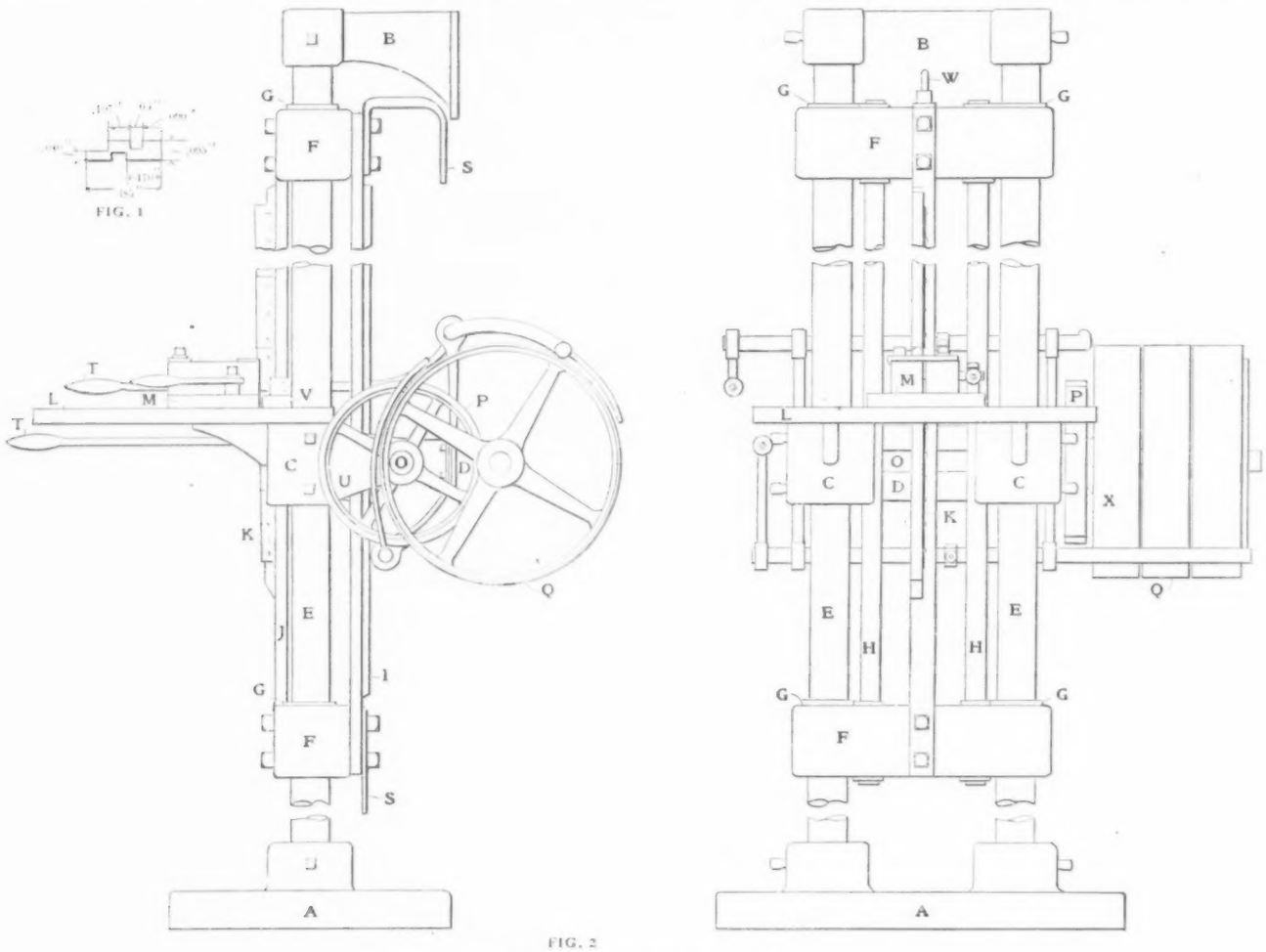


FIG. 2

THE WORK AND THE MACHINE

there are more cutting edges in contact at one time, more pressure required against the wheel and more heat produced; besides there is no room for the chips to escape until they have been dragged across the work, in some cases amounting to several inches and perhaps producing more heat than is done from the actual cutting done by the wheel. Using the bevel side we have only a line contact, taking less pressure for a given depth of cut, less heating and practically no dragging of chips over the work. In conclusion I might add that I have ground formed cutters from ⅛ inch thick by 5/8 inch diameter the slot lengthwise. They were formerly cast on a chill, making a very poor job, also very costly, as they had to be turned separately on an arbor.

Referring to Fig. 2, *A* is the cast-iron base, *B* top piece, *C* are castings with a machine-steel strip *D* screwed on the back to support the driving gear and table. The castings *C* are bored to fit the machine-steel bars *E*, and are held in position with set-screws having their points well bedded in the bars. The castings *F* are bored a press fit for the bushings *G* and the machine-steel tie rods *H* which are threaded and have nuts fitted on both loose. The bearings of the pulley shaft are separate from the machine. This is done to take the belt strain from the machine.

The belt shifters are actuated by the forgings *S*; they serve to stop the machine at the finish of both up and down strokes. For starting the machine the hand levers *T* are used. *U* are bronze back bearings for the racks.

The hook *W* is for a cable, which runs on sheaves above and back of the machine carrying a weight to counterbalance the sliding parts.

The machine stands against a pillar

which serves as a support for the top and center, also as a support for one pulley-shaft bearing.

There is a rotary hemp bush, not shown for clearness, such as platers use, in front of the broach under the table. It is hung on a pivot with a spring to hold it to the broach, and is driven by the grooved pulley *X*. This keeps the chips from lodging in the teeth of the saw. There is also a sheet-metal plate fastened back of the brush to prevent chips from getting on the rods.

The broach proper is in sections 3 inches long, this is a convenient length for hardening. Each section is held with three

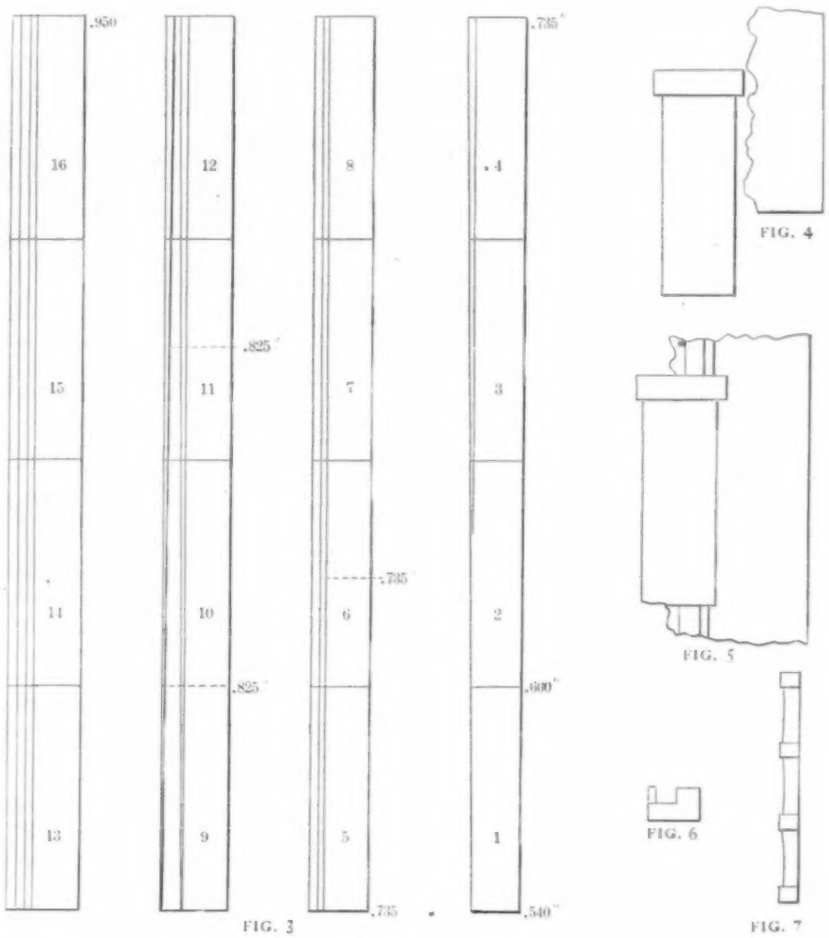


FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

THE BROACH

10x24-machine screws and two No. 20 dowel pins. Fig. 3 shows the arrangement of the saw and how the taper is distributed to bring the heaviest cutting where it is strongest.

Section 1 cuts through the flange and has 0.060-inch taper, from 2 to 5 it has about 0.044-inch taper per section; this brings it to the second groove, Fig. 1. The rib formed by the first groove is cut away, Fig. 6, and beginning at No. 5 it tapers to the side, to the center of No. 6, the front edge being straight here. The teeth on this part are cut so as cut on the side, to get past this angle. From the center of No. 6 to No. 10 the taper is about 0.026 inch per section; this brings it to the shoulder; the next one-and one-half sections are straight front and side taper the same as at the first groove. From the center of No. 11 to the end it tapers about 0.023 inch per section.

Fig. 4 shows the first section starting the cut and Fig. 5 shows the last section in the plug. In Fig. 4 are shown the form of front teeth, which were milled with a special mill; the work being set in the miller vise to a gage and using the graduated dial on the cross feed for spacing. There are four teeth to the inch. Fig. 7 shows the form of side-cutting tooth used, it being a combination of front and side tooth; they were worked out with a file.

The broach is relieved or scraped several thousandths both in the grooves and on the body as far as it enters the cut, this relieving coming up to the cutting edge. If this were not done the brass would stick to the broach and rough the slot.

Considerable difficulty was experienced in hardening the sections, but by heating in lead and using a hardening solution that gave toughness to the steel it was overcome. It was found best to draw to a purple, or so that a fine file would "bite."

Although to all appearances a delicate tool for the cut it has given no trouble whatever and has cut over 50,000 pieces. The plugs are now cut from the rod, both in soft brass and bronze, with a box tool and are slotted at the rate of 175 per hour.

K. E. LEMER.

Chicago, Ill.

Apprenticeshtp

In regard to apprentices I want to say that my experience with a good many boys in several different shops makes me agree with what Entropy says on page 60. I have never yet seen a contract between a firm and an apprentice that I thought was a good one. The promise of a bonus to be paid at the end of a boy's apprenticeship is in a good many cases, used to get a boy to work for almost nothing, and when he compares his week's wages with those of some other boy working free, there can be but one result.

One cannot tell what a boy will become in three years. He may become a cracker-jack or a jackass, and for my part I prefer a boy working under no contract restriction, which as Entropy says, makes him feel like the embezzler, and he usually has about as much money in his clothes.

I prefer to take a boy just as he is and teach him and push him as much as he is capable and give him a "raise" once in awhile. There are a dozen or more "boys" working in toolrooms in several cities, who learned their trade under my instruction and who think enough of my way of training to remember their old foreman, who isn't very old either, with frequent letters telling of their new experiences.

One great mistake lots of foremen make is to allow the apprentices to be imposed on. Another thing that a foreman should do, provided the boy is at all bright or willing, is to explain various things to him and not merely say "do this!" or "do that!" in a great big, gruff voice. I never yet had a boy working for me who did not endeavor to do exactly what I told him and I never "roared" at him either.

My shop practice is to treat a man as a man and a boy as a man that needs a little more watching and teaching.

Decatur, Ill. ETHAN VIALL.

Canadian statistics show a rapid growth in the exportation of mica from the Dominion. In the fiscal year 1896 the shipments were 558,419 pounds, valued at $55,627; in 1906, 1,329,634 pounds, worth $335,591; and in 1907, 1,732,903 pounds, valued at $632,560. The United States is the best customer, taking last year nearly 90 per cent., most of the balance going to Great Britain.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 1,151,500 *copies of the* AMERICAN MACHINIST. *Our circulation for March,* 1908, *was (weekly, monthly and European)* 96,750.

April 2..... 36,500

This paper reaches 36,500 *separate readers each month and* 20,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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A Needed Change in Our Patent Law

We have already informed our readers of the recent change in the patent law of Great Britain, whereby the manufacture of articles protected by British patents is made compulsory in Great Britain. The law, it will be recalled, is of the most drastic kind. While it gives to a patentee a liberal amount of time in which to begin the manufacture of the patented article, this period being four years, once the period has elapsed the comptroller, in case he is satisfied that the patented article or process is not manufactured or carried on to an adequate extent in the United Kingdom, is empowered to revoke the patent forthwith, although if satisfactory reasons for the delay are given, he may grant additional time at his discretion.

The spirit in which this law is to be enforced remains to be seen, but it is the result of a good deal of agitation in Great Britain, and if carried out in approximately the spirit in which the movement which brought it about was engineered, it is not to be expected that the comptroller will be lenient with patentees.

In enacting this legislation the British government has fallen into line with the other leading countries of Europe, in nearly if not quite all of which the working of a patent within the borders covered by it is made compulsory.

As matters stand today the United States remains the only country of the first rank in which the patent laws protect aliens in the manufacture of patented articles outside its own borders. Our tariff laws act to a considerable extent to counteract the influence of this policy, especially in cases in which patent protection does not give monopoly because of the patent being of a minor character, as well as those in which the patented article is on a strictly competitive basis with others, but in a vast number of cases this counteracting influence is not felt.

This is especially true of chemical industries which have had their origin in Germany. The tremendous advance of German chemical industries during recent years is well known to our readers, this advance being such as to place German manufacturers almost outside the pale of competition in many cases. It is quite clear that in cases of this kind, in which the goods do not compete with anything made in this country, the German manufacturer can send his goods to us and add the duty charges to the cost with impunity. Meanwhile his American patent makes it impossible for independent competition to be inaugurated here, the effect of our patent laws being to protect the German manufacturer's product produced in Germany.

In such cases the effect is to load the American consumer with added costs to no purpose except the building up of industries abroad—a result that is equally distasteful to the protectionist and the tariff reformer alike, and that is, in short, repugnant to common sense. We not only protect the foreign maker from any possible American competition, but we tax ourselves roundly to do it. If free-trade England has reasons to justify her new patent law, much more do we have reasons for enacting a similar law.

The effect of the new English law is already apparent, especially in connection with the establishing of branch factories of German chemical products. It is, however, reported that in two cases, and because of this new law, American manufacturers of mechanical products have already taken steps to establish factories in Great Britain, the chief of these being the United Shoe Machinery Company. To the extent to which the new law operates as it has in these cases, it will, of course, be prejudicial to American manufacturing interests considered in a national sense.

We need go no farther than across the boundary to the north to find an example of the results of this policy. For the past 20 years the Canadian government has required articles protected by Canadian patents to be made within Canadian lines, and while formerly the law was liberal, and still more liberally construed, it is now executed in accordance with its spirit. No one who is familiar with the tremendous growth of manufacturing in Canada during the past 10 years can fail to appreciate what this provision has done for that country. If this is the case under the restricted market conditions of Canada, which in an economic sense often lead to a loss from the establishment of branch factories there, how much more would the policy accomplish if enforced here? In most lines of goods we supply the largest single market in the world, and nothing but inertia and indifference or other reasons of a personal character offer objections to the making here of almost everything we consume.

It seems to us high time that this subject were agitated and action by Congress secured. A live mouse makes more noise than a dead elephant. A small active interest can easily push its problems to public attention, but in a case like this in which the interests concerned are purely passive and in which public and not individual welfare is concerned, Congress may be depended upon to let the matter rest for years before discovering of itself where the true interests of the country lie. The subject seems to us an eminently proper one for agitation by the National Association of Manufacturers.

According to a statement made by Le Chatelier, nitrogen in steel to the amount of 0.02 to 0.45 per cent. is sufficient to render the metal easily breakable and to destroy ductility.

New Tools and Machine Shop Appliances

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THE LATEST INFORMATION

Sturtevant Turbine Cupola Blowers

For many years the cupola fan blower has been driven by a belt from a steam engine or electric motor. The belted set is, however, undesirable, but direct-connection to an engine is out of the question because of the low speed of the engine. A direct-connected motor is possible, but suitable conditions are not often found in cupola work.

The steam engine is too complicated a machine for the foundry and like the motor must be constantly repaired and adjusted. It is subject to a marked decrease in economy as the valve, valve seat, and cylinder become worn; and the small clearance and reciprocating action expose it to dangers from water coming over from the boiler. A broken cylinder head may cause a long shut-down at any time, while the slipping of an eccentric may temporarily delay the operation of the blower. Although the steam engine is as economical as the steam turbine as regards amount of steam used, the turbine is operated at less cost when repair expense, deterioration, and lubrication are considered.

The direct-connected steam turbine has many points in its favor for driving the cupola blower. There are no belts to absorb power, cause trouble, and take valuable space. It is exceedingly flexible, the simple closing of accessible hand valves decreasing the power by reducing the amount of the steam admitted. The great flexibility and capacity for continuous operation with practically no deterioration make it adapted to the continuous service of supplying iron to converters in large steel works, or for all-day service in car-wheel foundries, as well as for foundry cupolas requiring blast but a few hours at a time. The turbine blower can be placed close to the cupola for it is en-

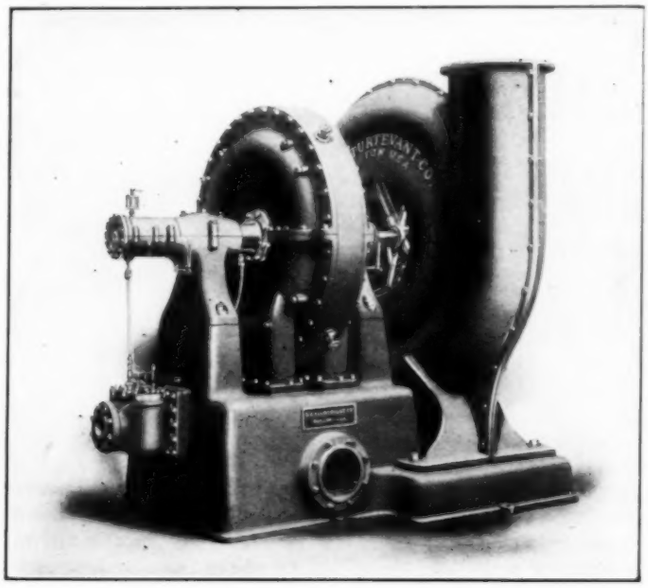


FIG. 1. TURBINE BLOWING SET

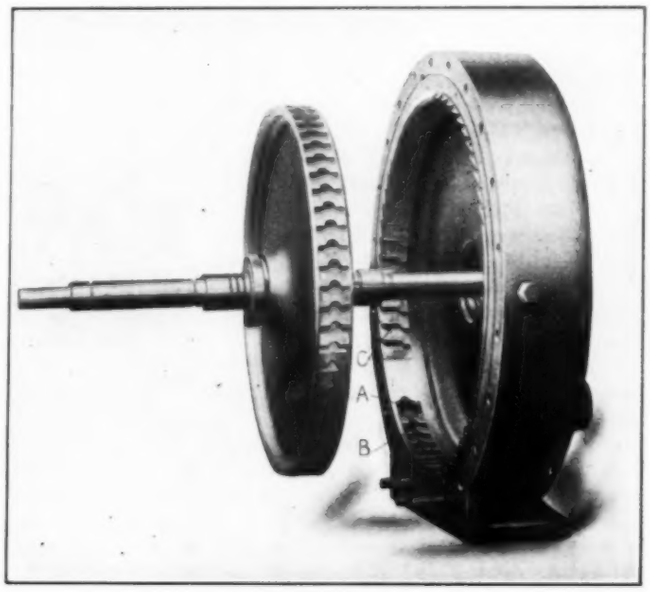


FIG. 2. CONSTRUCTION OF TURBINE

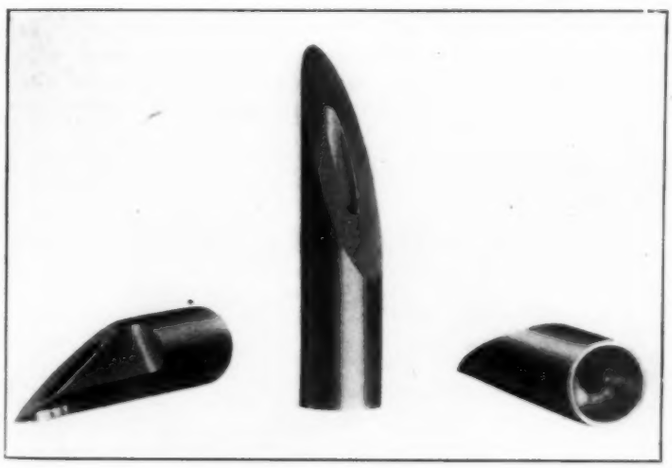


FIG. 3. THE NOZZLES

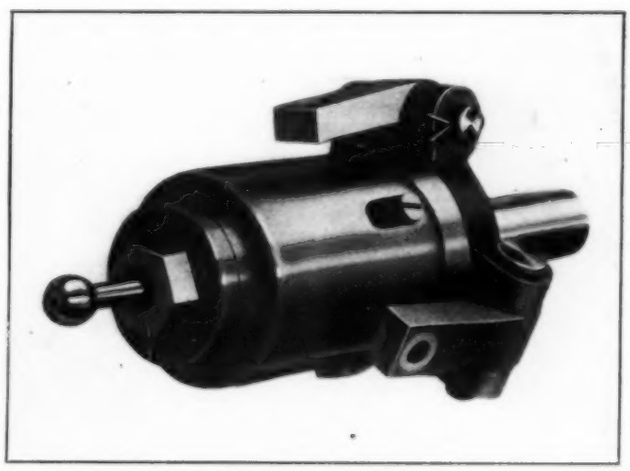


FIG. 4. THE GOVERNOR

tirely inclosed, dust-proof, and not affected by heat; thus losses due to friction of air flowing in pipes are avoided.

The Sturtevant cupola blower consists of a fan blower and Sturtevant turbine on the same base as shown in Fig. 1. The shaft of the turbine is supported in the bearings and extended for the overhung fan wheel. This compact construction eliminates all but two bearings, and even the coupling is omitted.

To obtain durability and simplicity, the buckets of the Sturtevant turbine wheel are cut out of the solid forging; the buckets being placed in the rim in order that the steam pressure may be perfectly balanced. The wheel is very strong and durable for there are no inserted blades. If because of wear on the bearings or lack of alinement the wheel should touch the casing, no harm would result for it would merely run without pressure. With a large number of separate buckets such action would be disastrous.

Surrounding the bucket wheel is the stationary reverse guide ring of forged steel. See Fig. 2. In this ring are inserted the steam nozzles of Tobin bronze, Fig. 3, and two sets of buckets or reversing chambers. In one set, which is of the form shown at B, the chambers are of the same shape as the buckets in the rim of the wheel, and with them form closed spaces. The other buckets *C* are similar in shape, but are cut away at one edge. The steam enters through the nozzles *A* and acts upon the buckets in the wheel, then reacts in the reversing buckets, and so returns again and again to the wheel remaining within the closed chambers formed by the two sets of buckets. The steam returns each time at reduced velocity, and more and more of its energy has been taken by the wheel. After acting in a group of these closed spaces, the steam enters the buckets *C* cut away at one edge, and is exhausted into the casing which is in communication with the exhaust. The returning of the steam to the same wheel results in high efficiency, and permits of moderate rotative speed which ranges from 1600 to 3000 revolutions per minute. Similar speed is obtained in some types by the use of elaborate gears, and in others by mounting several wheels on the same shaft.

The bearings which support the turbine shaft are of the ring-oiling self-alining type with solid linings of phosphor bronze. These are exceedingly durable, and as lubrication is abundant they last indefinitely. The speed turbine is regulated by a centrifugal throttling governor, Fig. 4, on the end of the shaft. No belts or gears or other speed-reducing devices are necessary for the governor is direct-connected to the shaft. Changes in speed of the revolving weights are transmitted to the regulating valve as shown in Fig. 1. This is built by the B. F. Sturtevant Company, Hyde Park, Mass.

Internal Grinder

The engravings illustrate an improved internal-grinding machine built by the Heald Machine Company, Worcester, Mass. Front and rear views are shown in Figs. 1 and 2 and details of the headstock and wheel head in Figs. 3 and 4.

The table is of ample length and with wide bearings, and the ways are protected with guards to prevent the entrance of grit or dust and provided with oil pockets and rolls for the uniform distribution of oil. The headstock is mounted on a bridge casting of rigid construction and is arranged to swivel to various angles for grinding taper holes, it being graduated in degrees and in inches taper per foot. The chuck spindle is ground and lapped, and runs in phosphor-bronze boxes which are dustproof and adjustable for wear. In Fig. 3 will be seen the adjusting nuts

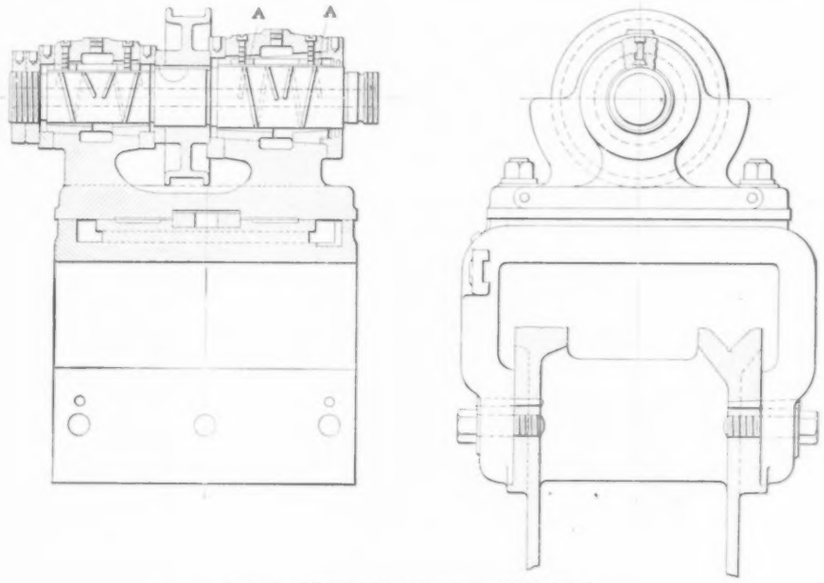


FIG. 3. INTERNAL GRINDER HEADSTOCK

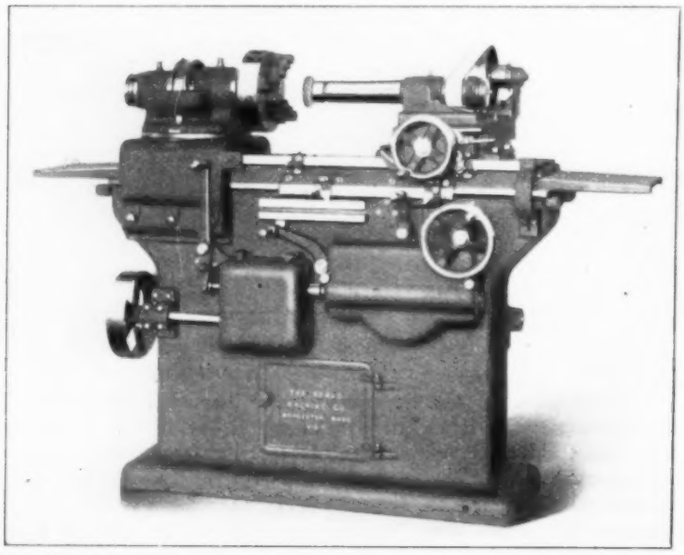


FIG. 1. FRONT VIEW, INTERNAL GRINDER

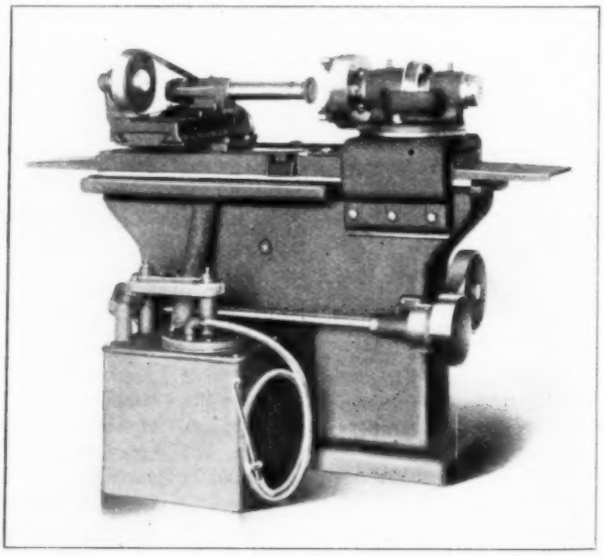


FIG. 2. REAR VIEW, INTERNAL GRINDER

for the boxes; *A A* are dovetail wedges which seat the boxes in the head. A ¾-inch hole is drilled through the chuck spindle, as a convenience where collet chucks, etc., are to be used for holding work. The head spindle is driven by belt from a five-speed quick-change gear box mounted overhead and forming part of the countershaft. In this way suitable work speeds for holes of different diameters are obtained and in addition the operator can instantly speed up the work during the finish cut to secure a highly finished surface.

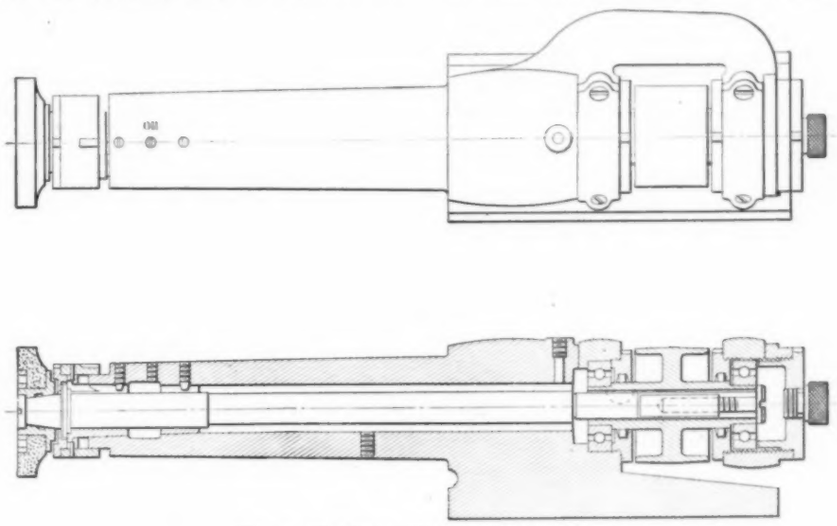


FIG. 4. INTERNAL-GRINDER WHEEL HEAD

On the front of the base is mounted the automatic table-reversing gear box, and at the left the three-speed quick-change gear box for giving the table three different rates of travel for each work speed. A fast travel for roughing out stock, and slower speeds for truing and finishing the holes are, thereby, always at hand. The different speeds are controlled by the vertical handle at the left end of the gear box. All changes of speeds and feeds are readily controlled from the front of the machine and can be made without stopping either the table, the work, or the wheel.

The wheel spindle, Fig. 4, is hardened, ground and lapped, and runs in a phosphor-bronze box at the wheel end, which is provided with means for compensating for wear. The pulley bearings consist of double radial ball bearings. The wheel heads are self-contained and interchangeable so that different sizes can be quickly substituted when changing from the grinding of large holes to small holes or *vice versa*. This also enables a single extra head to be used on several machines if so desired. The diameter of the driving pulley on the different wheel spindles is made proportional to the diameter of the grinding wheels used on that spindle, so that the correct speed for any given wheel is obtained automatically. The smallest size wheel head is suitable for holes of ⅞-inch minimum diameter and 4 inches in length; the largest head for holes 3 inches diameter and larger, by 11 inches in depth. The actual swing of the machine is 14 inches and the diameter of the largest hole it is designed to grind, 10 inches.

The construction of the cross slide is clearly shown in the half-tones, together with the mounting of the wheel head, the idler pulley and the method of belting. The cross feed to the wheel is arranged to be operated either by hand or automatically at either one or both ends of the table travel. Provision is made by which the feed is automatically thrown out when work is to size. The feed ranges from 0.00025 to 0.003 inch at each reversal of the table.

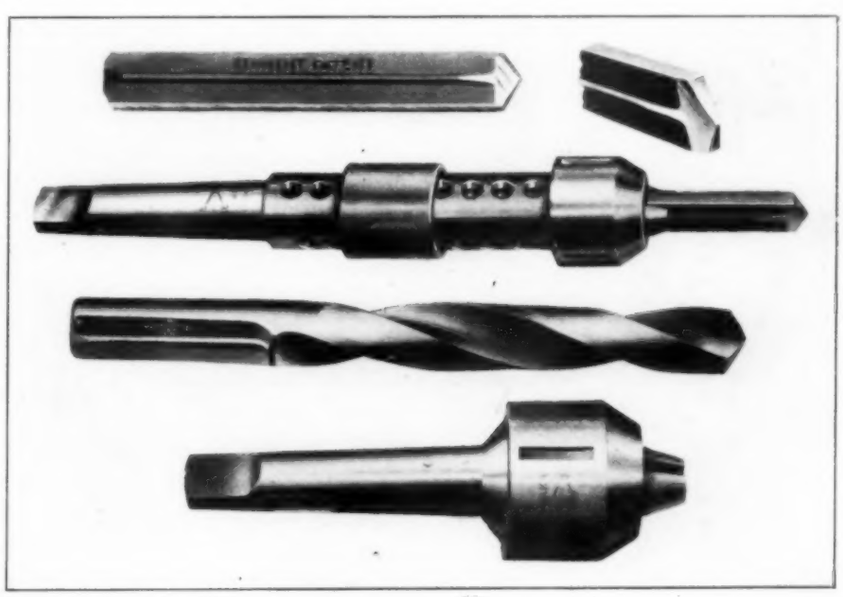
The idler pulley is fitted with radial ball bearings and is adjustable on the cross slide to maintain proper belt tension at all times. It has two steps, the smaller being driven from the countershaft and the larger driving the wheel spindle at proper speeds with a moderate speed of the countershaft. The construction of the wheel head provides an outer bearing for the driving pulley, which is so supported that endless belts can be used and yet be put on or taken off instantly without adjustment of any kind. This allows the wheel heads to be easily and quickly changed.

Practically all the bearings in this machine, including those in the gear and speed boxes, are fitted with adjustable anti-friction bushings which can be easily removed at any time if it should become necessary and new ones substituted without affecting original alinements. The countershaft arrangement contains a steel drum 12 inches diameter by 30 inches long for driving the wheel spindle, a five-speed box, with friction clutch and quick-acting brake for driving and stopping the chuck spindle, and tight and loose pulleys for belt from the main line. Provision is made for the use of water, the table having channels leading to a tank at the rear of the machine. This tank is made with a settling chamber for the grit and the clear water upon passing to the pump chamber is supplied again to the work by a centrifugal pump mounted on the tank and so constructed that all bearings are above the water.

High-speed Drills and Drill Chucks

The illustration shows two types of high-speed steel drills and two types of drill chucks for gripping them.

At the top a flat drill is shown. This drill is recommended for shallow drilling, say two to three inches deep, where an accurate size of hole is not required, in hard material. The drills are so



HIGH-SPEED DRILLS AND DRILL CHUCKS

tempered that almost the entire drill may be used.

The upper chuck shown is for holding the flat drills. The drill is gripped so that only enough of it projects to go through the work, thus reducing the torsional strain on the drill. The upper end of the drill fits in a plug held in place by a cross-bar which is retained by the upper sleeve. The holes in the chuck are for the reception of the cross-bar which is easily set in conjunction with the plug and retained by the sleeve. The flat drills and chucks are known by the trade name "Economy."

The twist drill shown is made of high-speed steel twisted while hot. The flat tang has heads as shown which fit depressions in the jaws of the chuck, shown beneath it; these center it. The twist drills and chucks for holding them are known by the trade name of "Norka."

The tools described are made by the Whitman & Barnes Manufacturing Company, Chicago, Ill.

A Motor-driven Cutter and Reamer Grinder—Bench Centers

Fig. 1 shows a machine with a double countershaft for cylindrical work such

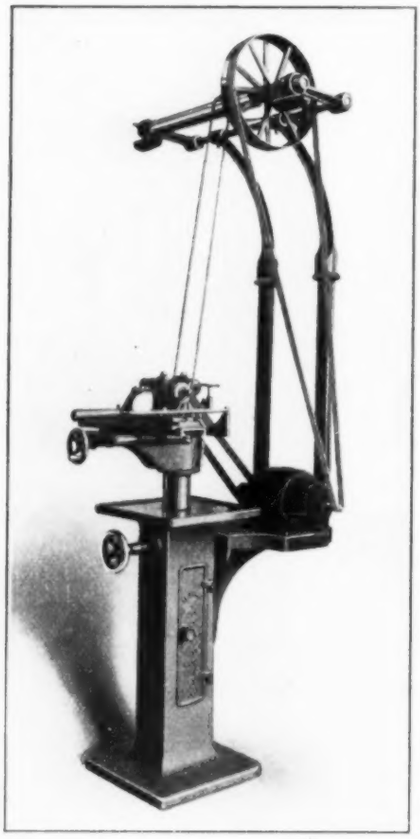


FIG. 1. A MOTOR-DRIVEN GRINDER

as arbors, etc., and can be furnished with complete universal equipment. The spindle is driven direct from motor-shaft and the other end of the motor-shaft drives the overhead drum, which in turn revolves the work by means of the small round belt. An idler which does not show in cut is used to keep the belt from drum to circular centers always the right tension regardless of the position of the carriage.

The motor is dust-proof, and is placed in such a position that the table can

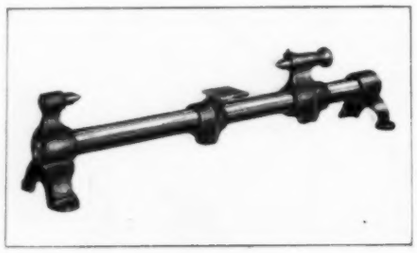


FIG. 2. BENCH CENTERS

swing so as to present work at any angle to the wheel without interfering with any belts, or the upright standards which support the countershaft.

Fig. 2 shows a bench center. The tail center is held in place in the center with a spring so that work can be taken in and out quickly, and the spring is of the right tension to hold pieces true while allowing them to revolve freely. It is also adjustable lengthwise for pieces of different length. In connection with the hand rest shown a test indicator can be furnished which will tell in thousandths how much the work is out at any point.

These tools are made by the F. E. Wells & Son Company, Greenfield, Mass.

A Revolving Oilstone Scraper Sharpener

The machine shown in Fig. 1 was principally designed for the purpose of properly sharpening machine scrapers.

The machine will grind the face perfectly straight, or slightly convexed, if so desired, always making sharp-cutting

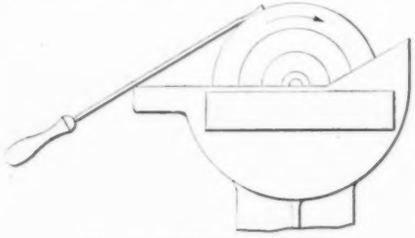


FIG. 2. GRINDING CONCAVE

edges on the two edges. By holding the scraper on the stone as shown by Fig. 2, the sides will be ground concave, this giving two acute angles at the cutting edges which cause the scraper to cut very freely.

For grinding the edge, the scraper is held in a vise which is attached to compound slides, and by the use of the hand lever the vise and scraper are moved back and forth, as well as laterally across the face of the stone. By these two motions the scraper is moved over the whole face and keeps the stone worn straight.

For gripping the scraper quickly and accurately in the vise a small platform is provided which is always in line with the face of the wheel and parallel with the lines of motion of the two slides.

The feed is regulated by the adjusting screw at the front of the machine.

Other purposes for which the grinder can be used in machine shops, is touching up and putting a keen, smooth edge on threading or any other tools on which a keen, smooth edge is required. When doing work like this the scraper holding the attachment can be thrown back out of the way.

The oilstone wheel is run in a bath of kerosene, which prevents heating the tool,

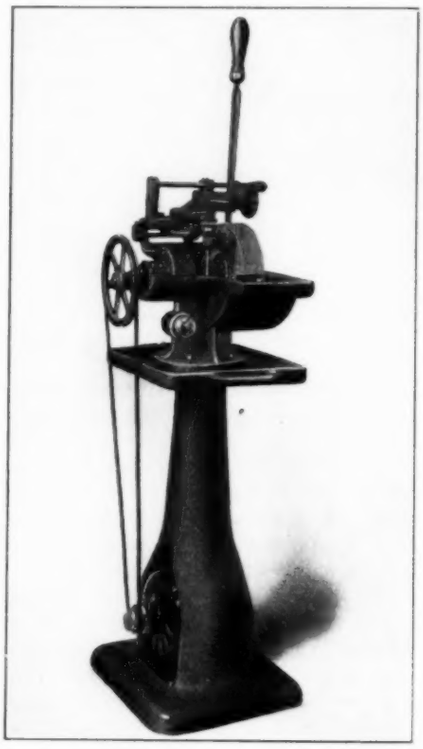


FIG. 1. A REVOLVING OIL STONE SCRAPER SHARPENER

and keeps the surface of the wheel clean and sharp, not permitting it to glaze. It is driven through a set of spur gears with a ratio of two to one. Arrangements are made so the stone will not throw any oil.

The illustrations show the machine driven by a motor placed in the hollow of the pedestal. These motors, ⅛ horsepower, are furnished for either direct or alternating current, and are driven from the electric-light circuit, connections being made simply by screwing any incandescent-lamp socket onto a plug back of the machine. A small snap switch for starting and stopping is placed at the front, and in easy reach of the operator.

The machine is also furnished, when de-

sired, with countershaft for belt drive instead of the motor drive.

This machine is built by Mummert, Wolf & Dixon Company, Hanover, Penn.

A Gould & Eberhardt Automatic Rack Cutting Machine

An automatic rack cutter of new design has just been brought out by Gould & Eberhardt, Newark, N. J. The accompanying half-tones, Figs. 1, 2 and 3, illustrate a machine of this type having a length of bed sufficient to cut a rack 6 feet long at one setting. Another size is made having a bed of such length that a rack 8 feet long can be cut at one setting, and a heavier machine for 10-foot lengths. By shifting the rack in the vises on the machine it is, of course, possible to cut a rack of any length. The maximum width of face for which these machines are designed is 10 inches. It should be needless to point out that this may be either in one wide rack or in several narrow racks. The cutter slide is operated on the familiar "draw-cut" principle.

The aim in developing this line of machines has been to obtain a maximum of rapidity and accuracy, and easily operated tools particularly adapted to the modern requirements of high-speed cutting steels.

The Bed

The bed is a single casting of the box type. The illustrations show its outline. Where it rests on the floor it is T-shaped, and has bearing spots at positions which correspond with the ends of the bar and the end of the stem of the letter T. In this particular it parallels the design of many modern tools.

The interior of this bed in front, as shown in Fig. 1, is used as storage space for the indexing change-gears. Similarly, space at the rear beneath stanchion slide is used for the cutter speed change-gears.

The sides of this bed are well tied together by ribs or webs, which in some cases serve the additional purpose of partitions between parts of the interior. By this means four chambers or pockets are formed beneath the stanchion slide. These are to receive chips and lubricants. A drip pan of ample width crosses each end and the front of the table. In front and at about the middle of the table's length is an opening which connects with a space beneath the table and below the table screw. This space is in turn drained into one of the four chambers in the bed, which we have mentioned. An apron or shield is placed directly beneath the cutter arbor with its upper edge in contact with the under side of the table and serves to receive most of the lubricant dropping from the cutters and to convey it into the same compartments in the bed. Still another feature of this lubricant-retaining system is the trough running the full length of the rear of the bed and plainly shown in Fig. 2. The chambers are so arranged that the lubricant is strained through two screens and then made to rise around a baffle plate before entering the chamber from which the pump suction is taken.

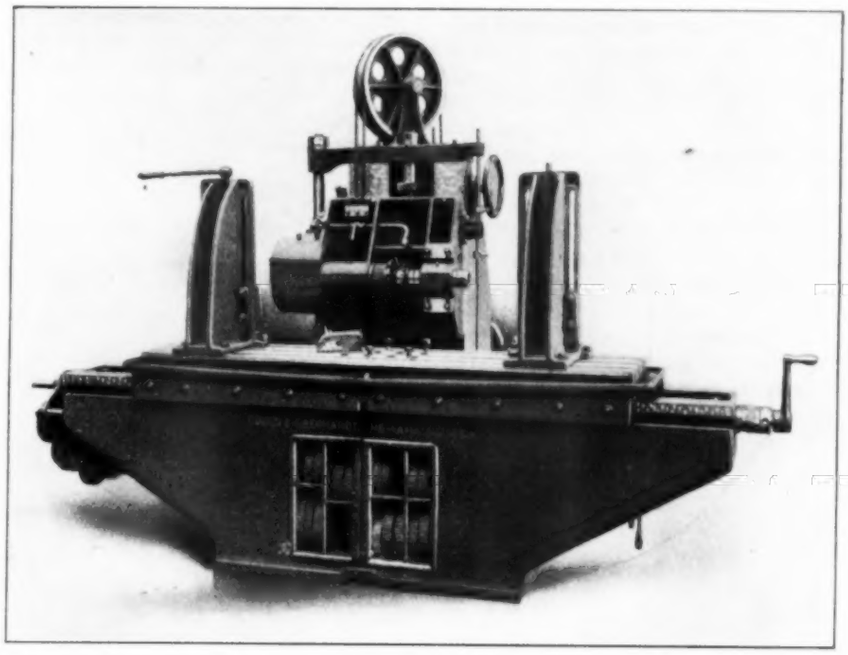
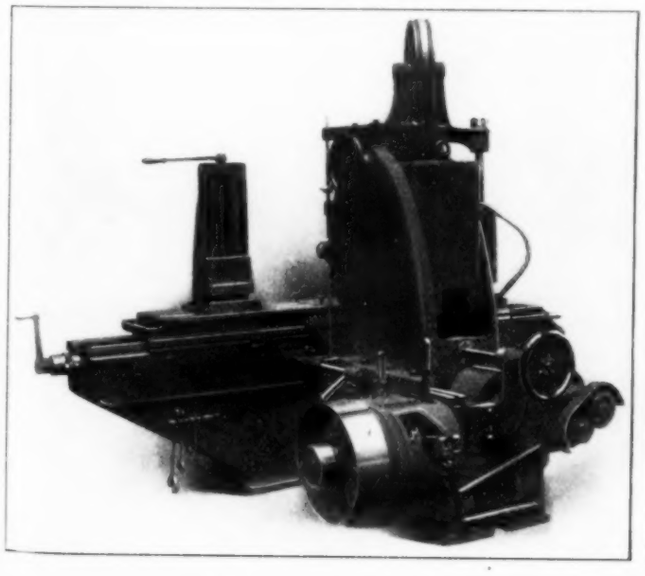


FIG. 1. FRONT VIEW OF NEW GOULD AND EBERHARDT AUTOMATIC RACK CUTTER

There is an opening on one side of the machine for the removal of chips. In case the work requires no lubricant, a shield is provided which diverts the chips to the floor through one of these openings and does not allow them to enter any of the chambers.

The Stanchion

The stanchion is also of a box construction stiffened by two backward-extending,



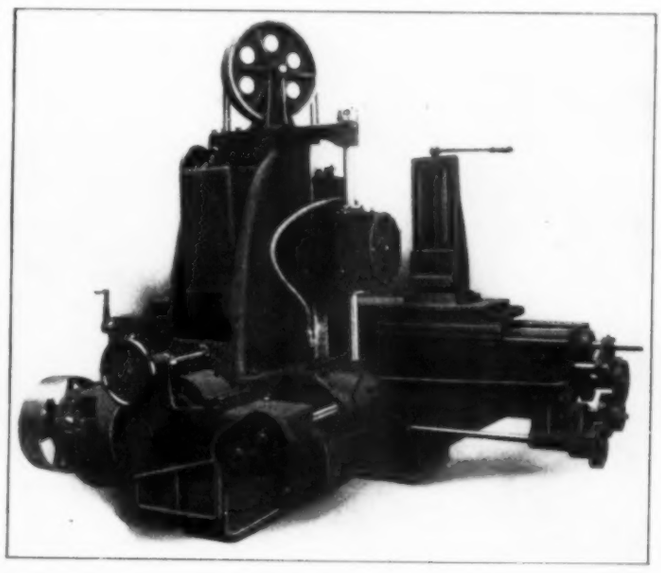


FIG. 2 TWO REAR VIEWS OF GOULD AND EBERHARDT AUTOMATIC RACK CUTTER FIG. 3

elliptical-shaped, gridironed webs. It rests upon flat ways and is held down by studs fitted into straps entering T-slots. Its position in and out is regulated by the hand-wheel shown at the rear in Figs. 2 and 3. This hand-wheel has a micrometer dial used to get the correct setting of the cutter as regards depth.

The Drive

The drive is from a constant-speed pulley, which can be seen in Figs. 2 and 3. The motion to the cutter spindle is transmitted by heavy shafts and gearing to the vertical shaft shown paralleling the stanchion in Fig. 3. This shaft carries a worm meshing with a worm wheel on an auxiliary shaft, which in turn is geared to the cutter spindle by two pairs of spiral gears. These pairs are right- and left-hand, respectively, so as to equalize the thrust. One gear of each pair is made from steel and case-hardened, while its mate is made from steel and left unhardened. The vertical shaft driving the worm has double keyways so as to equalize the strains. There are six cutter-spindle speeds in geometrical progression with limits of 12 and 76 revolutions per minute, respectively. The great length of the bearing of the cutter slide on the stanchion face should be noted, also the position of the cutter spindle, nearly central with the length of the slide. These features, together with the character of the drive and the size of the bearings, have been given close attention in order to obtain a maximum of rigidity and freedom from chattering under the heaviest work. To this end, also, one pair of spiral gears is located close to the cutter. This feature can be seen in Fig. 1, as the gear case has been removed.

The range of the machine in pitches is from fine pitches up to 1½ diametral pitch and coarser pitches may be cut by blocking out the teeth previous to finishing. When cutting the larger pitch, the machine is intended to carry two cutters, a rougher and a finisher. For the finer pitches, however, a larger number of cutters may be used up to 12. The indexing mechanism is arranged for either 1, 2, 4, 6, 8, or 12 cutters, depending upon the pitch.

Cutter Speeds

Sixteen speeds in geometrical progression from ¾ inch to 14½ inches per minute are obtained in the gear box, best seen in Fig. 2. This range is such that all classes of work should be economically handled.

Indexing Mechanism

At the left-hand end of the machine is the indexing or dividing mechanism, best seen at the right-hand edge of Fig. 3. The screw is single-threaded No. 6 diametral pitch. By a simple method of compounding, diametral, circular, module and millimeter pitches can be cut within the general range of 1½ to 18 diametral pitch. This simple method is in direct contrast to that required by other mechanism in which the screw must be changed. At the left-hand end of the table is an auxiliary adjustment working between the limits of 0 and ¼ inch, operating on the table-screw bearing and intended to be used for setting work for recutting, or in case it is necessary to take a light chip from one side of a tooth or teeth. A reversing mechanism is provided in connection with the table-operating mechanism so that the table can be moved in either direction as desired. This obviates the necessity of returning the table when a new blank is set.

Safety Devices

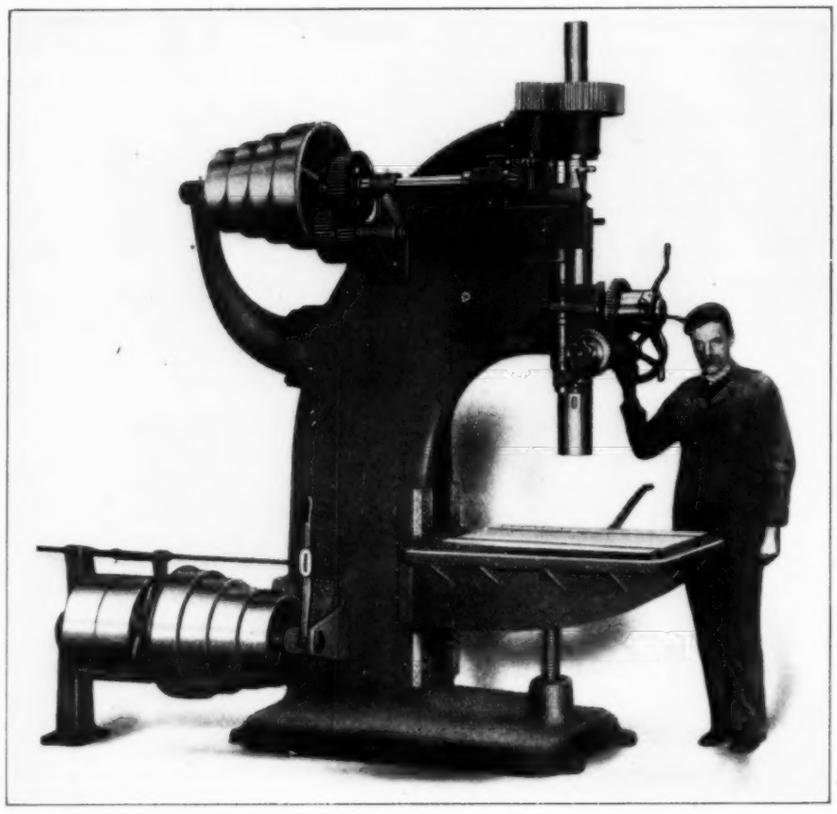
One of the important features of this design is the safety devices surrounding the feeding mechanism, so that it is impossible for the cutter slide to feed downward unless all of the preceding divisions and movements have been properly completed. Thus, if the end of a rack is reached the cutter-slide feed will be thrown out and feeding will stop entirely, instead of allowing the cutter to pass and repass through the same tooth space until the machine receives attention from the operator. Adjustable stops are provided on the back of the table, one of which can be seen in Fig. 2. These can be set to throw out the mechanism controlling the advance of the table at any predetermined point. The advance of the table can also be made continuous, thus permitting the machine to be used as a milling machine for facing work, and the like.

Work-holding Devices

With each machine are furnished three vises, two of which are shown in position on the table in Fig. 1, and the other on the floor near the left-hand edge. The holding-down bolts for this vise are shown in place in T-slots of the table. The table has been designed with unusual care in order to avoid any springing or distortion which might take place from excessive tightening of these vise bolts.

A High-duty Drill

The illustration shows a high-duty drill designed to use high-speed steel drills up to 3½ inches diameter to their full capacity. It is built in two sizes 44- and 60-inches swing, with either straight or right-angle drive.



A HIGH-DUTY DRILL

The spindle is of steel 3½ inches diameter in the quill. The quill is 23 inches long and is provided with a ball thrust for spindle, in which ¾-inch balls are used.

Three changes of geared feed are provided, together with power feed, hand worm feed, automatic stop and quick return lever. The table is fitted to rectangular slides and is clamped by straps. To further increase its stiffness a 3-inch square-thread screw is provided which also acts as an elevating screw.

This machine is built by the Foote-Burt Company, Cleveland, Ohio.

A Pipe Die Stock

In this die stock the cutting edges of the chasers are considerably shorter than usual, but as they advance upon the pipe they are automatically expanded and in this manner they produce a correctly tapered thread necessary for tight joints. The short chasers, everything else being equal, require less power than those of regular length; they have the further advantage in this die of being easily removed and ground.

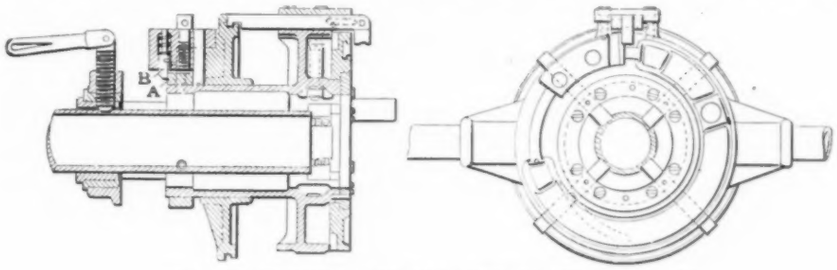


FIG. 2. SECTIONAL AND END VIEW OF THE DIE STOCK

In this stock there is no threaded leader, instead, a face cam is used for this purpose; its position is shown in Fig. 2 at *A*, the pin *B* working on its inclined face, as the die is rotated, draws the chasers to the pitch. The threads start without any extra exertion on the part of the operator and through the employment of the cam leader the tool is not limited to threads of the same pitch nor to the one direction of lead, as with it both right- and left-hand threads can be cut.

The dies and stock are so constructed that a number of sizes may be cut with the one set, as for instance with that shown all pipe sizes from 1 inch to 2 inches inclusive.

In Fig. 1, in front and to the bottom of the die head, the cutting-off attachment is shown. By means of it pipe may be cut off rapidly and smoothly without burs. The head is provided with pockets into which the oil, injected to the dies, lodges and from which it drips to the work as the die is rotated. As soon as the dies have been screwed onto the pipe far enough to complete a thread of sufficient length they stop cutting and release themselves from the work. A slight turn of the controlling cam plate by hand then enables the dies to clear the threads and the die is removed from the work. In proceeding with the cutting of a duplicate thread the dies are instantly reset by turning the cam plate till the stops touch.

This die is made by the Hart Manufacturing Company, Cleveland, Ohio.

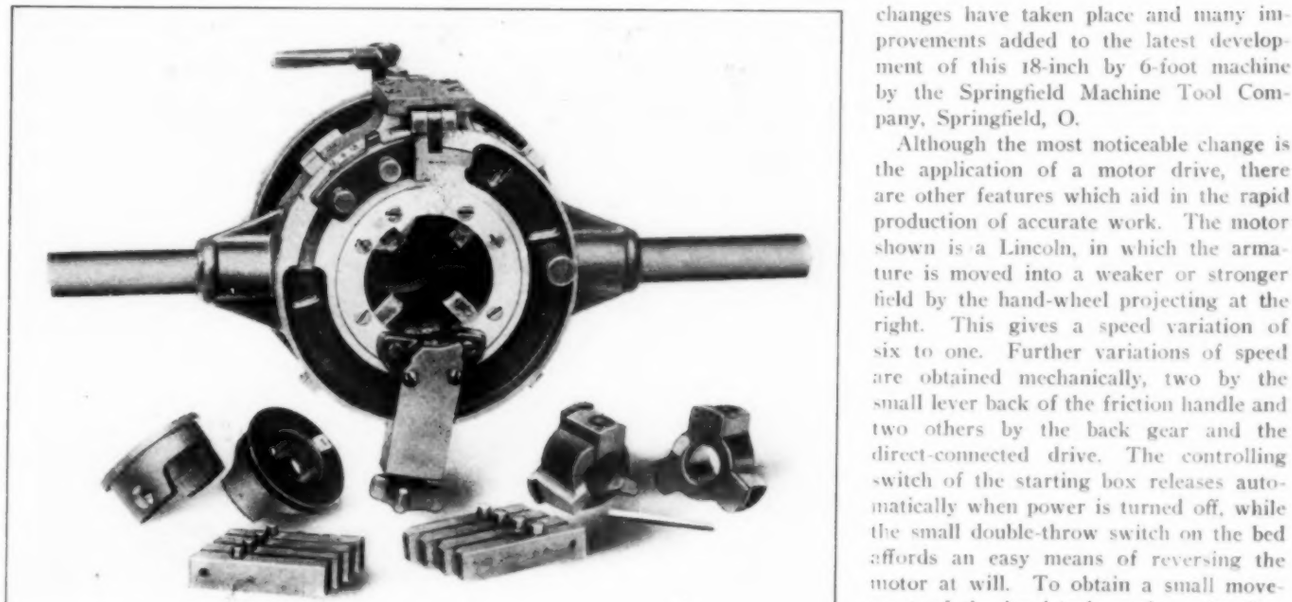


FIG. 1. THE DIE STOCK WITH CUT-OFF ATTACHMENT

Motor-driven Fox-turret Lathe

Those who remember the Fox lathes of twenty years ago will see that many changes have taken place and many improvements added to the latest development of this 18-inch by 6-foot machine by the Springfield Machine Tool Company, Springfield, O.

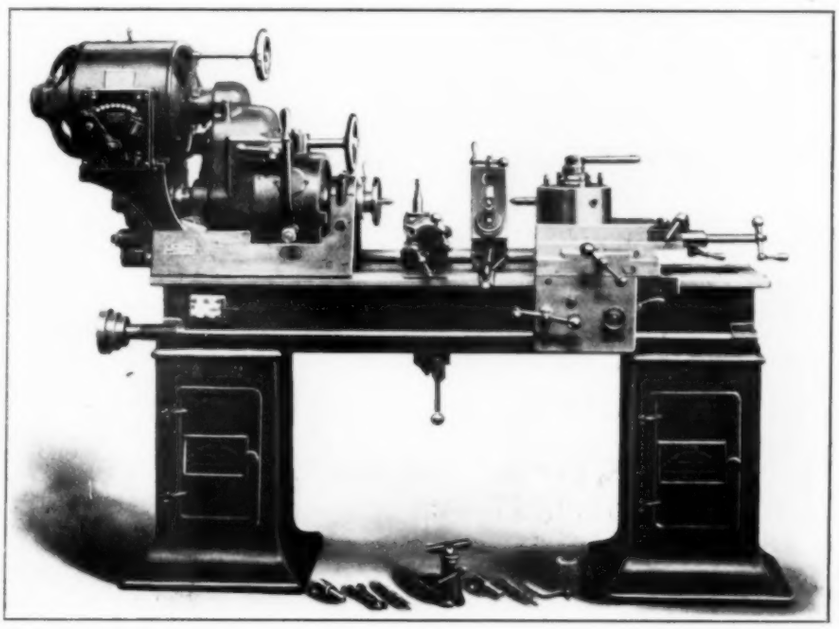


FIG. 1. MOTOR-DRIVEN FOX-TURRET LATHE

Although the most noticeable change is the application of a motor drive, there are other features which aid in the rapid production of accurate work. The motor shown is a Lincoln, in which the armature is moved into a weaker or stronger field by the hand-wheel projecting at the right. This gives a speed variation of six to one. Further variations of speed are obtained mechanically, two by the small lever back of the friction handle and two others by the back gear and the direct-connected drive. The controlling switch of the starting box releases automatically when power is turned off, while the small double-throw switch on the bed affords an easy means of reversing the motor at will. To obtain a small movement of the headstock, such as is often convenient to bring the tool to the end of the thread, the hand-wheel directly over

the main bearing is used. The friction head and the self-oiling bearings have long been a feature of these machines.

Instead of the regulation slide rest which was always a part of the older lathe, a compound rest is provided that can be operated in almost every position. It is graduated in degrees and can be clamped by a set-screw over the lower handle. The chasing bar is regular, the

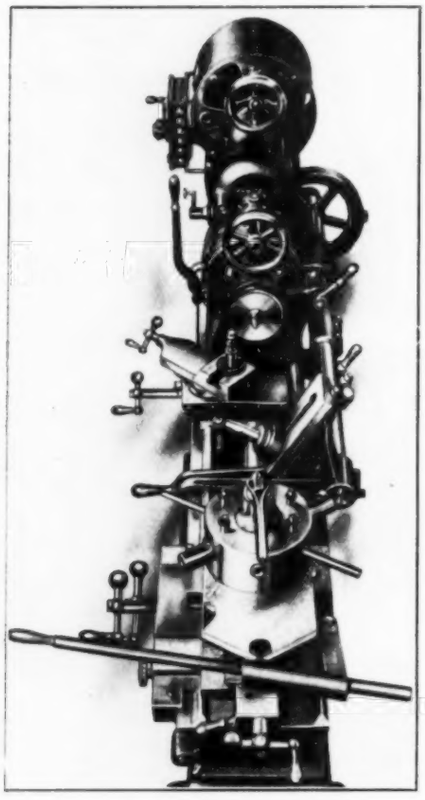


FIG. 2. AS IT LOOKS FROM ABOVE

most important feature being the tumbler gear which reverses the leader or hob, as some call it, so that right- and left-hand threads can be cut with the same one.

The turret has several interesting features. The indexing is obtained by the handle above, a backward movement releasing the locking pin in the base and holding it while the forward movement of the same handle turns the turret into its new position and the locking pin holds it in place. This handle also locks the turret to the slide. Both screw and lever feed are provided.

There is a taper attachment, with the bar in the center of the bed and with this any taper up to 4 inches per foot can be obtained for turret-tool boring. Ample provision is made for taking up wear and a taper pin locates and holds the slide central when desired. The turret has cross feed and the apron in front gives power feed along the bed through the friction disk. The direction of feed is reversed by the small lever behind the apron and the ball handle allows hand movement at will. Means of clamping firmly to the bed are also provided at the end of the carriage. The turret holes are bushed, taper gibs are provided for all turret and cross-slide movements and other details seem to be as carefully looked after.

The top view makes a striking picture and shows the location of the various handles from an entirely different point of view.

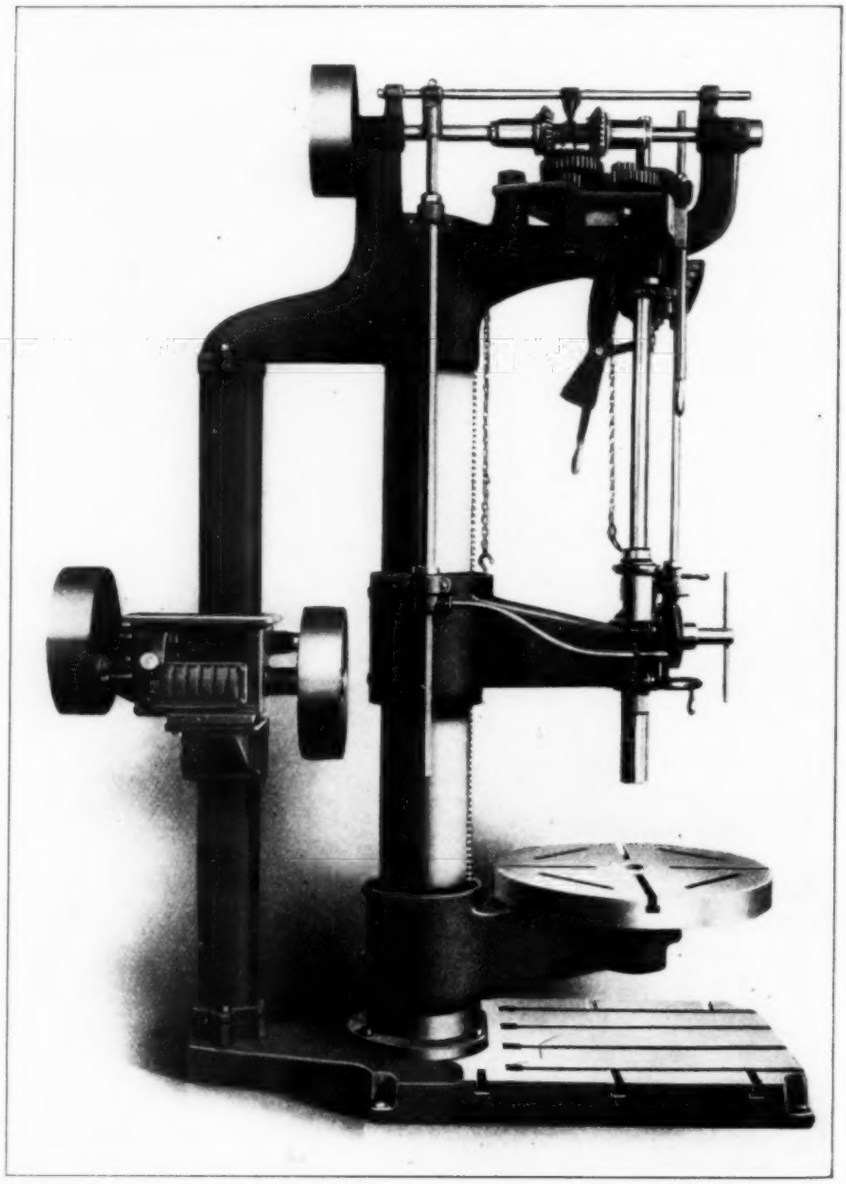
A Triple-geared Upright Drill

The round column is provided with a bottom flange bolted to a ribbed T-slotted base and is supported by a back brace, which connects the base and top housing. The back brace carries the speed-changing device, which receives power from a large single pulley. This single pulley allows the machine to be set in any direction under the line shaft, either at right angles or parallel therewith. The speed variator is simple type operated by one lever only and providing six different speeds, arranged in geometrical progression. These six speeds are increased to 18 near the spindle. The spindle has two gears, a large one and a small one for high speed. No gear runs idle and when the back gearing is thrown in, the gears of the medium and high speeds are thrown out and the same applies in the other two speeds.

The tapping mechanism consists of two miter gears provided with band-friction clutches, which are adjustable for wear. The lever is right in front of the operator and he can operate it for the purpose of stopping, starting or reversing the machine. The reversing of the spindle can be done at any speed.

The automatic spindle feed is a positive gear feed and has changes of speed. Hand feed and quick return and approach movements, also an automatic trip are provided for the spindle.

The spindle stock has long bearings



A TRIPLE-GEARED DRILL PRESS

and surrounds the column. It slides down to the top of the table arm so that the spindle will nearly touch the base. This feature allows the omission of the raising and lowering mechanism of the arm and table. Spindle and table arms are box-girder shape and each is clamped to the column by means of two clamping screws.

The machine will handle high-speed steel drills to their fullest capacity. Hight of machine over all 112 inches; drills to center of a 36-inch circle; distance from spindle to base 56¾ inches; distance from spindle to table 37½ inches; traverse of spindle 15 inches; weight 3800 pounds; floor space 80x30½ inches. This machine is built by the Hilbert Machine Company, Cincinnati, Ohio.

A New Sensitive Drill Press

The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., have recently brought out a variable-speed sensitive drill press of an entirely new design. See Fig. 1. It has several novel and interesting features not embodied in any machine before placed on the market. Between the driving shaft and the spindle no cones or quarter-turn belts are used, but the power is transmitted to the spindle by means of a double disk and roll friction designed to give an instantaneous variation of speed. The essential feature in this device is a cam clutch, combining a positive drive and tightener which increases or decreases the pull of the disk on the roll as required by the work. This action is entirely automatic. The pressure between the rolls and disks is very slight except when drilling. These features are shown in the half-tone, Fig. 2.

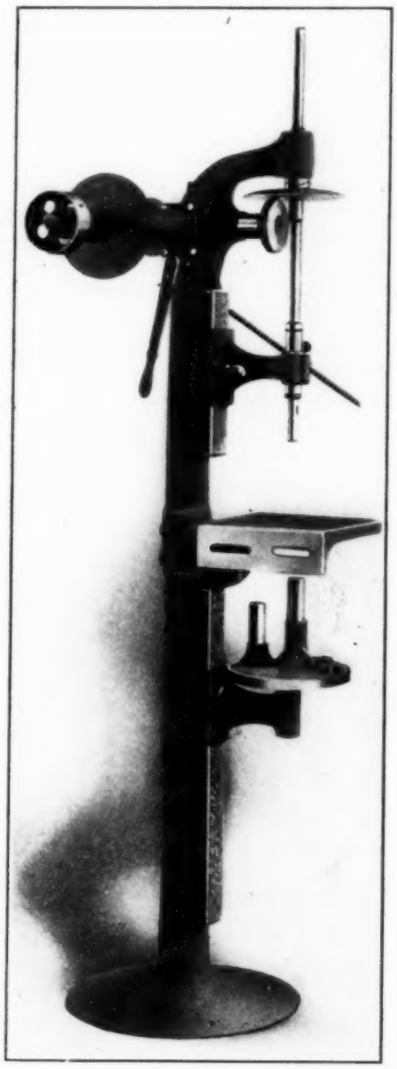


FIG. 1. SINGLE-SPINDLE SENSITIVE DRILL PRESS

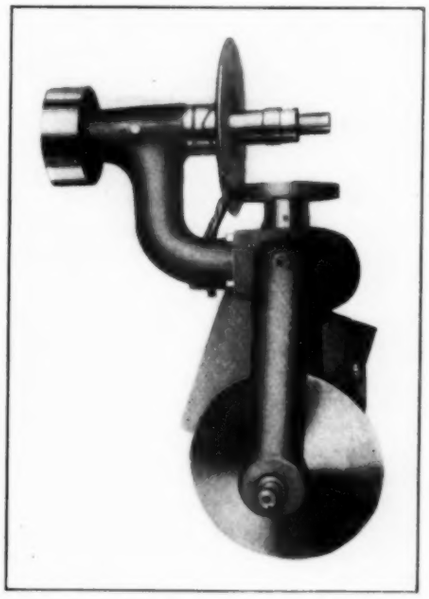


FIG. 2. SPINDLE DRIVE OF NEW SENSITIVE DRILL PRESS

The variation of spindle speeds is obtained by throwing a lever attached to a segment gear which meshes into a rack cut on the roll carrier. The extreme movement of the rack is only two inches for a range of speed from 4 to 1. This sliding of the rolls across the disks is easily accomplished, as there is but very little normal pressure on the rolls except when drilling. There is no excuse for not running the drill at exactly the proper speed.

No countershaft is required with this machine. To stop the spindle the speed lever is thrown to its extreme position, and while in this position the driven roll is out of contact with the driving disk; the disk is recessed for this purpose. The elimination of the countershaft in the multiple-spindle type is especially advantageous, not only in the ease with which the variations of spindle speeds may be obtained without the trouble of shifting belts, but each spindle may be started or stopped at will independently of any other spindle. The design also presents a neat appearance, because the cones and quarter-turn belts are eliminated.

Each head of the multiple-spindle type is a unit in itself and the heads may be slid along the column to as close as 10-inch centers. Any head may be taken from the column or extra heads added as the work requires. The head is fastened to the column by a tee-bolt set at an angle and the head is drawn into position by the lever nut showing in Fig. 3 at the rear of the machine.

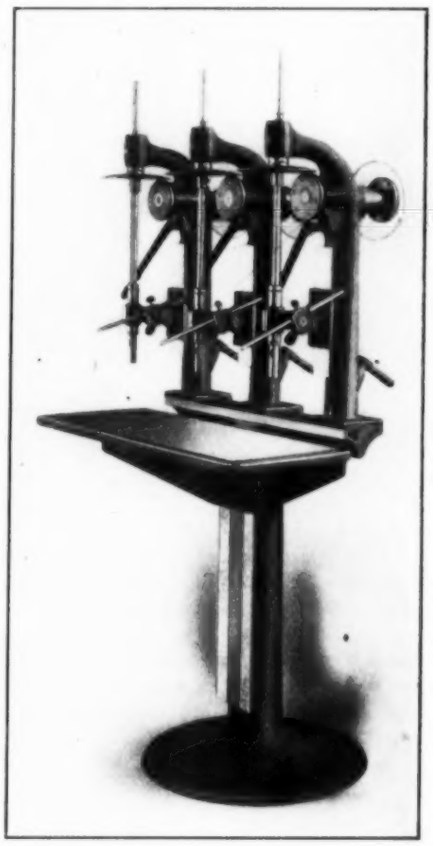


FIG. 3. THREE-SPINDLE SENSITIVE DRILL PRESS

Referring to the line cuts, Figs. 4 and 5, the working of the machine is as follows: Power is applied to the pulley on the driving shaft *A*. Running on this shaft and keyed to it is a sleeve *B*. This sleeve carries one-half of the cam clutch, the other half of which, *C*, is made part of the disk. This disk runs free on the sleeve and is engaged while operating by a fiber roll *D* mounted on the roll shaft *E*, Fig. 5. On the opposite end of this shaft is another roll of the same diameter *F*. This engages a friction disk *G* of the same diameter as the first. Therefore, as the roll *D* travels from the point as shown at the smallest diameter of the disk to the largest diameter its speed is increased, and at the same time the roll *F* moves from the largest to the smallest diameter of the disk *G*, which also increases the speed of that disk and through it the speed of the spindle.

The drive of the spindle *H* from the disks *G* is obtained through a cam clutch similar to that on the driving shafts. One-

half is carried by the sleeve *I* running in the bearing of the head and driving the spindle by a sliding key *S*. The other half is part of the disk *G*. When the drill is started the two parts of each clutch engage. As greater pressure is applied to

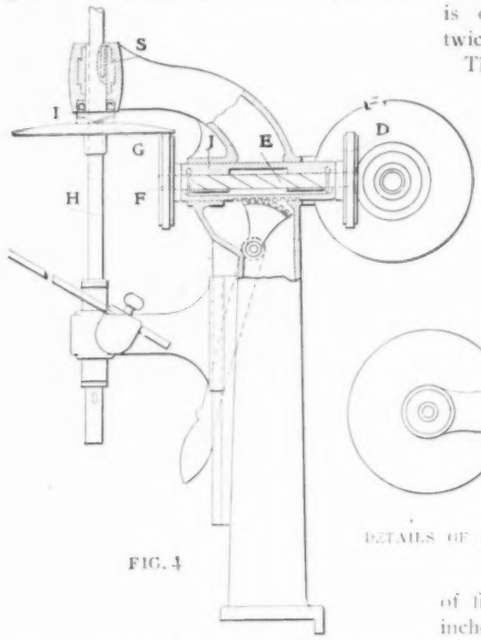


FIG. 4

the drill point, the cam surfaces move relative to each other, thus increasing the pull upon the roll. This automatically increases the driving power as required at the drill point. The central portion of the driver disk *C* is recessed so that when the roll *D* leaves its slow position it is out of contact with the disk and the machine is idle.

The roll shaft is carried in a self-oiling bearing *J*. The rolls are moved across the face of the disk by means of a segment gear *K* engaging with a rack cut in the bearing *J*. The ratio of the rolls to the disks is such that a spindle speed is obtained ranging from one-half to twice the speed of the driving shaft.

The disks are of cast iron and the rolls

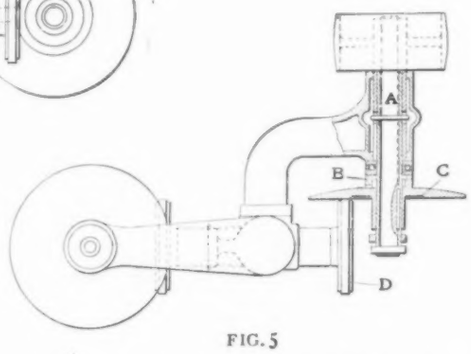


FIG. 5

DETAILS OF SPINDLE DRIVE OF NEW SENSITIVE DRILL PRESS

of fiber. The spindle has a travel of 3 inches and the head a vertical adjustment of 7½ inches. The diameter of the spindle in the sleeve is ⅞ inch and is bored to receive a No. 1 Morse taper. The single-spindle machine weighs about 250 pounds, the two-spindle 450 and the three-spindle 650.

The drill press is no experiment, having been thoroughly tested for several months by every-day use at the Washburn Shops. It is designed for sensitive drill work and will carry both carbon and high-speed drills up to 9/16 inch at their proper speeds and feeds.

Surface Grinder

The engravings illustrate a grinder built by Wilmarth & Morman Company, Grand Rapids, Mich., which machine may be furnished for surface grinding pure and simple, without any attachments, or it may be equipped with cutter- and reamer-grinding attachment which is mounted upon the surface-grinding table for handling large face mills, small angle cutters, reamers, etc., thus converting the machine into a universal type of cutter and reamer grinder. When desired, the spindle can be extended and the new "Yankee" drill-grinding attachment made by the same concern can be used. The surface-grinding table may be operated entirely by hand feed, or fitted with automatic feed as desired. If supplied with automatic feed this may be for longitudinal movement only, or both longitudinal and transverse feeds may be automatic. General views of the machine arranged for different classes of operations are given in Figs. 1 to 4. Fig. 5 shows the spindle and its boxes.

The spindle, which is ground and lapped, is supported close to the wheel and driven by a two-step pulley. The bearings are of phosphor bronze 8 inches and 5 inches, respectively, in length, and 2 inches tapered to 1½ inches in diameter. Convenient means are provided for adjusting either box independently. The housings for the bronze boxes are bored

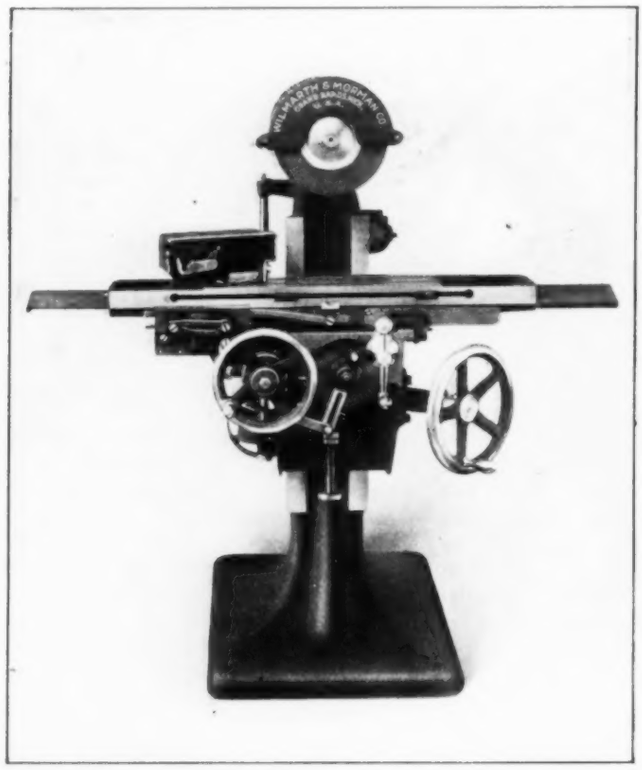


FIG. 1 SURFACE GRINDER

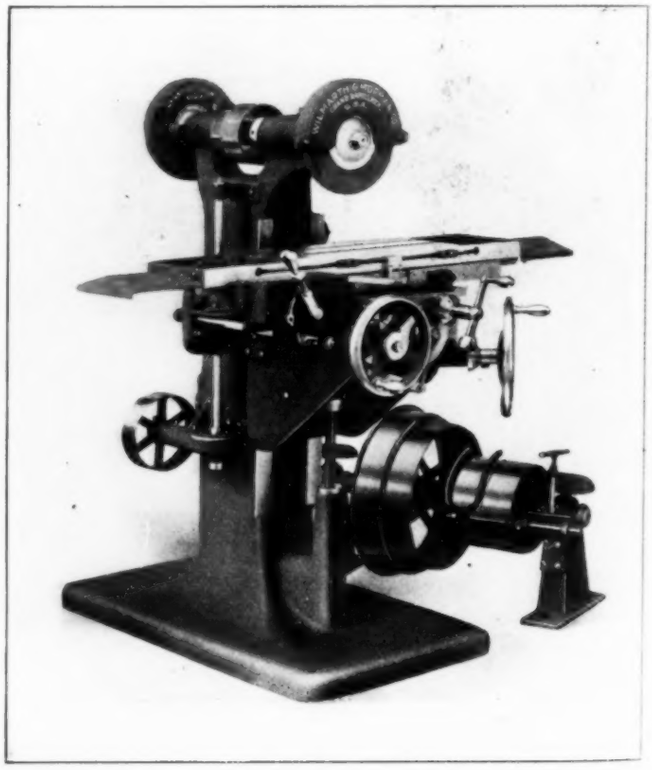


FIG. 2

in the main column to insure permanent alinement of spindle bearings. As seen in the line engraving lubricant is supplied from oil chambers through felt wicks. Surplus oil that may run to the front of the taper bearings is returned to the oil chambers by small channels. The bearings are protected from dirt.

Where the grinder is furnished as a plain hand-feed machine, longitudinal movement is by means of the hand-wheel at the left of the front of the knee; this is a plain rack-and-pinion type of feed. Transverse movement is by means of the ball-crank handle and screw at the right of the front of the knee. The vertical adjustment, operated by the hand-wheel at the right of the knee is by means of bevel gears operating the elevating screw which runs in a bronze nut. The weight of the knee and table is carried in large part by a ball bearing on the elevating screw, and is thus removed from the column bearings. The transverse feed is indexed by thousandths while the vertical adjustment is indexed to one-half thousandths. When automatic feeds are used the drive is by means of bevel gears with a reversing clutch on the vertical shaft. The reversing mechanism is placed in front near the left side of the saddle. The lever may be placed to hold the reversing clutch in a neutral position when desired, thus leaving the machine free for hand feeding. The weight of the reversing clutch is counterbalanced to provide a free working mechanism.

The transverse feed when used is applied or released by means of a friction device operated by means of the small nurled hand-wheel in the center of the large longitudinal feed-wheel. The transverse feed may be arranged to feed in either direction at the will of the operator. The amount of feed also may be regulated at will.

The gears and the ways are well protected, as will be seen from the illustration. The saddle is 36 inches long, thus giving ample bearing for the table. The front bearing is a sharp V-way, while the rear way is broad and flat. A gib is attached at the rear of the table to prevent any tipping tendency when excessive load is placed on the overhanging end of the table at its extreme limit of travel.

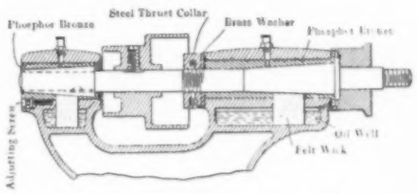


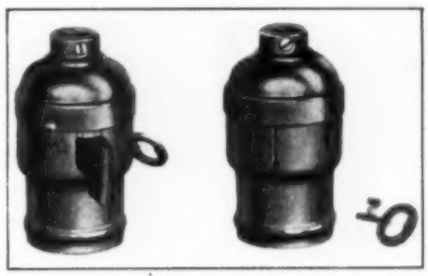
FIG. 5. SPINDLE CONSTRUCTION

The table is 8x50 inches, and has a working surface 8x20 inches. The machine is designed for a 10-inch wheel for ordinary surfacing work, and with a wheel of this diameter, has capacity for work up to 11½ inches in hight. The spindle-driving cone has steps proportioned for proper speeds for both 7- and 10-inch wheels; the 7-inch wheel is used for cutter- and reamer-grinding work, and may be used for ordinary surfacing where circumstances make it preferable. With a small wheel work up to 13 inches in hight may be accommodated.

The cutter- and reamer-grinding attachment has a capacity for handling all kinds of milling cutters, including face and side mills up to 13 inches in diameter. It can be secured on the table of the surface grinder by two bolts. The addition of the drill-grinding attachment does not interfere with the use of the surface grinder, as one operator may be doing surface grinding while another may sharpen a drill without either being in the other's way.

A Lamp Socket That Locks

The General Electric Company is just putting out a new lamp socket which prevents lamps being removed from their sockets by sneak thieves. In the old locking sockets the lamp was held rigidly so that bulbs were frequently broken in an attempt to remove them. This is reversed in the new socket as the shell turns freely, making it impossible to unscrew the lamp until the shell is locked with a key.



LAMP SOCKET THAT LOCKS

As will be seen, the locking mechanism does not detract from the appearance of the socket and the security for lamps will

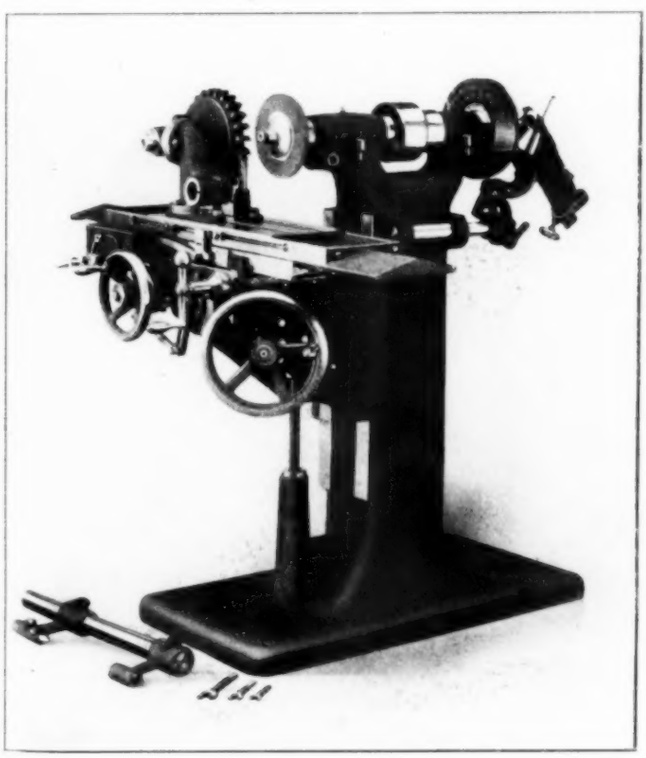


FIG. 3. SURFACE GRINDER WITH CUTTER AND DRILL GRINDING ATTACHMENTS

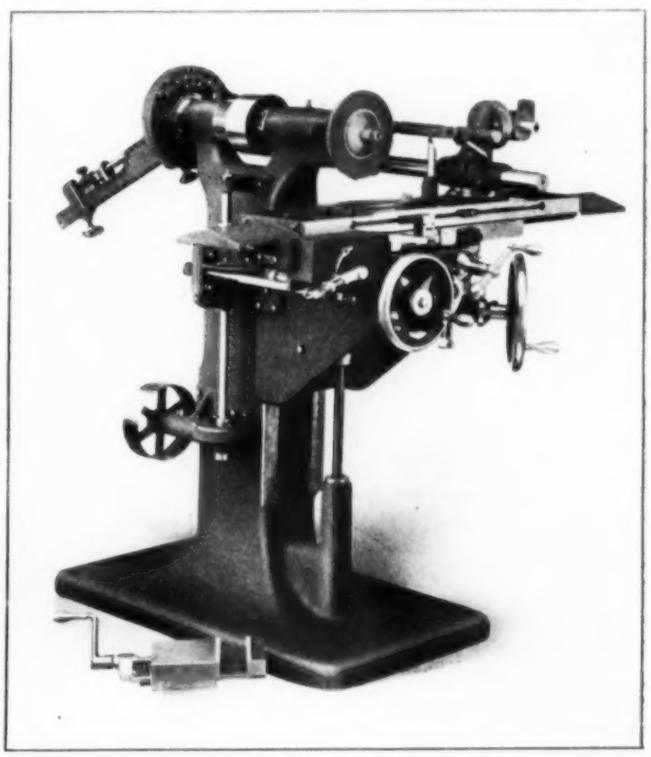


FIG. 4. SURFACE GRINDER WITH REAMER AND DRILL GRINDING ATTACHMENTS

be appreciated by many, especially those contemplating the use of tantalum, tungsten or other high-priced lamps.

Ring and Disk Grinder

The increasing use of gas engines has created a demand for a machine for grinding the sides of the piston rings and the accompanying illustration shows a new one being built by the Saxon Ma-

RING AND DISK GRINDER

chine Company, Holyoke, Mass., which has been designed with ample weight and rigidity to handle any work within its capacity, with accuracy and rapidity.

The head which carries the wheel is also adjustable so that work may be ground thinner or thicker at the center than at the circumference, which is particularly suitable in grinding saws and similar cutting tools. It is also provided with three rates of feed for the wheel across the work so as to handle all kinds of roughing and finishing. The spindle is provided with adjustable bushings thoroughly protected from dust and in this way perfect bearings can be maintained even after the machine has been in use for some time. The feed is automatic but can be operated by hand if necessary at times.

The work is held either by plain or magnetic chucks on the vertical spindle which is driven from the lower gear box and has eight different speeds for work of varying diameters. The elevation of this spindle is controlled by the hand wheel in front which is graduated to thousandths of an inch.

The machine is regularly fitted with a magnetic chuck which can be used either with 110 or 220 volts and be connected directly to a lamp socket. If, however, direct current is not to be had a small generator is furnished which can be placed in any convenient location and the wires brought to the chuck. A chuck of this kind takes no more current than an ordinary lamp.

The machine is driven direct from the line shaft so that a countershaft is unnecessary. It can be supplied with magnetic or plain chucks varying from 8⅜ to 12⅜ inches in diameter. The wheel is 8x¾x2 inches and the spindle is 46 inches from the floor. The greatest distance between center of the wheel and base of chuck is 12 inches. It occupies a floor space 26x45 inches and weighs about 1300 pounds.

A Peculiar Drill Combination

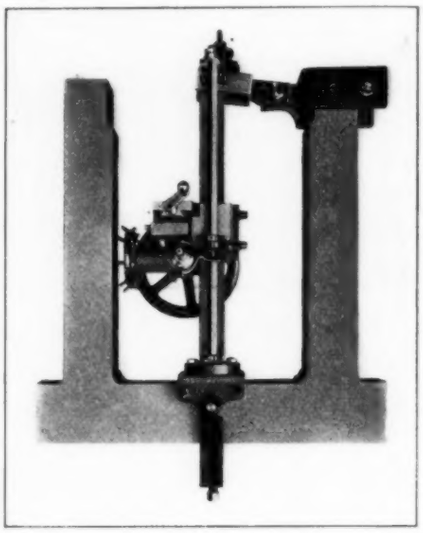
While we occasionally see a long table made to serve two or three drills, where the work is passed from one to the other for different drillings, these are usually independent of the regular tables and allow each drill to use its own table as desired, we do not recall just the combination shown in this illustration. Here the round tables are omitted and the table supports are used for the universal table, which can be raised and lowered at will. A general base is provided for the four drills, being wider at one end to accommodate the larger drills and bring the spindles of all the drills in line. The table is long and narrow and is slotted to receive the special work for which it was designed.

The smaller drills are 21-inch, fitted with power feed, automatic stop and quick return, while the 28-inch drills have sliding head, back gear, positive geared feed and tapping attachment.

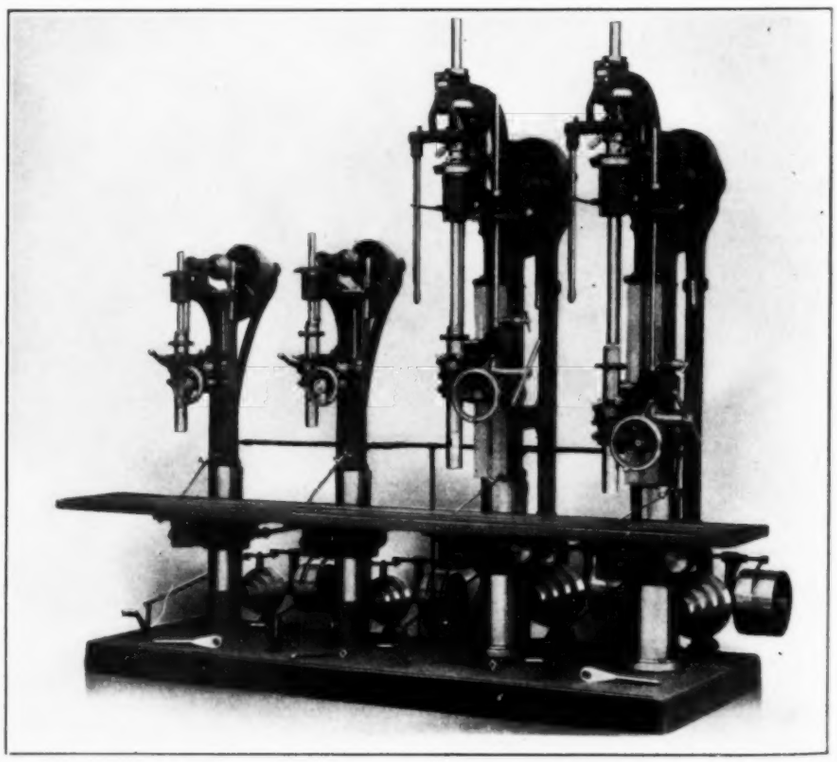
It would be interesting to know what work these were designed for but it shows one of the many combinations that are possible in the grouping of drills for special work. These were made for Shanks & Co., Barrhead, Scotland.

Facing Locomotive Pedestal Jaws

The machine consists of a square bar (adjustable by means of a swivel for either leg) upon which is a carriage carrying a milling head. The square bar is clamped to the frame and the head set by means of the slides. The feed is automatic by means of a nut and screw



MACHINE FOR FACING PEDESTAL LEGS



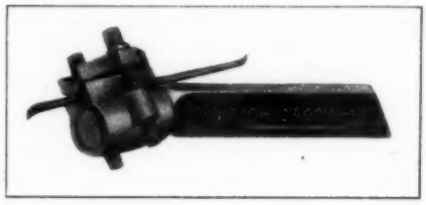
A PECULIAR DRILL-PRESS COMBINATION

actuated by the eccentric shown in the center of the half-tone. The milling cutters carry blades of high-speed steel.

Power is applied through a telescopic shaft provided with universal joints. The manufacturers make a two-cylinder air or steam motor which is adapted for driving this machine. It is made by H. B. Underwood & Co., Philadelphia, Penn.

A Boring-tool Holder

The half-tone shows a boring-tool holder possessing some novel features. The holder proper, as distinct from the shank, consists of a V-block having an



A BORING-TOOL HOLDER

opening beneath it, which embraces the cylindrical outboard end of the shank. The part which surrounds the end of the shank is slotted from end to end so that it will clamp securely in any position on the shank end. A double V-shaped cap fits on top of the tool and the two clamping screws not only clamp the tool between the cap and V-block but clamp the V-block on the end of the shank. The cap is so shaped that by reversing it, large boring tools, up to one inch diameter, can be held. The illustration shows the holder with a small tool in position. The adjustment of the tool for hight is, of course, accomplished by swinging the clamp on the end of the shank, and adjusting the tool in the V-block.

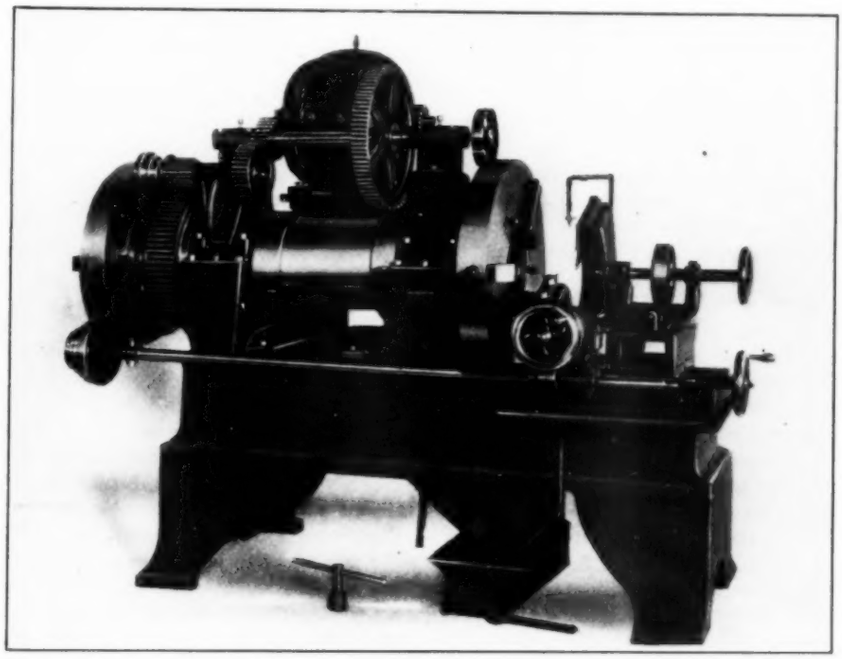
This toolholder is made by Carl F. Mayer, 479 North Clark street, Chicago, Ill.

Steel Spur and Bevel Gears from Stock

The Boston Gear Works, of Norfolk Downs, Mass., has taken up the manufacture of standard steel miter and bevel gears with generated teeth. The gears will be made of three grades of steel, the stock gears being of 0.15 carbon steel, while for extra heavy service gears of 0.40 to 0.60 carbon and for extremely severe service gears of chrome nickel steel will be supplied. The same company is preparing a list of high-grade stock steel spur gears of the usual type and also spur gears having helical teeth of about 10 degrees angle.

New Speed Control for Cutting-off Machines

The illustration shows the latest cutting-off machine of the Hurlbut-Rogers Machine Company, South Sudbury, Mass., which differs from their regular machines in being driven with a variable-speed motor to give the increased spindle and work speed as the cutting tools approach the center.

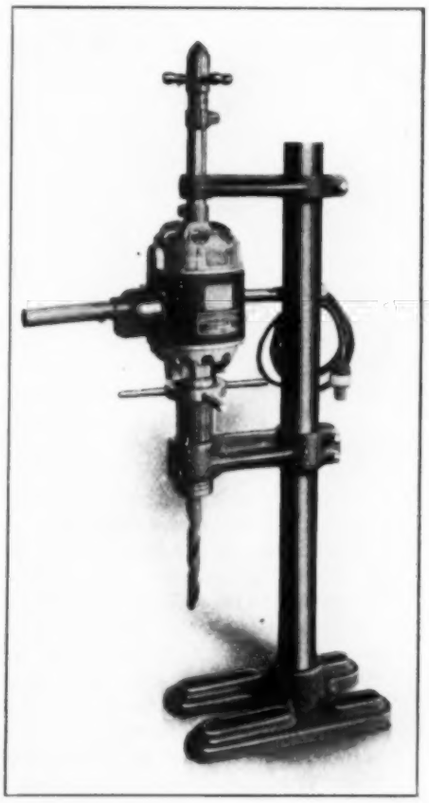


NEW SPEED CONTROL FOR CUTTING-OFF MACHINE

Instead of the friction-disk speed control in the belt-driven or with the constant-speed motor drive, this machine carries the spindle speed by having the tool blocks regulate the controller of the motor as they are fed in toward the center. Starting with the speed which gives the right cutting speed for the outside diameter of the bar, the tool blocks are connected by rocker shaft and levers, so that they speed up the motor to maintain a constant cutting speed. These connections are not seen, but as they do away with the friction drive of the other type, this is even more simple than the constant-speed drive.

Portable Electric Drill

The machinist of today who is given an electrically driven drill such as shown in the illustration will never appreciate the backaches and the hard work he has been spared by being freed from the use of the ratchet and the "old man."



PORTABLE ELECTRIC DRILL

This drill has a motor of the air-cooled type with a ball bearing to take up the thrust and will drill up to 1¼ inches in diameter in steel. It has a positive feed of 3 inches and can either be bolted down to the work or braced from above as desired.

It is built by the United States Electrical Tool Company, Cincinnati, Ohio.

The new developments in Gem, Tantalum and Tungsten lamps, in addition to the growing heavy demand for Edison lamps, has been the cause of the General Electric Company increasing its facilities for lamp production until now the total production aggregates sixty million lamps per year.

The Tenth Annual Convention of the National Metal Trades Association

The convention of this association was held at the Hotel Astor, of this city, March 25 and 26. The attendance was unusually large and the entire convention was pervaded with an unmistakable spirit of go.

After the usual opening formalities at the session of Wednesday morning, the report of the retiring president, H. M. Barker, was read.

The President's Report

This report congratulated the association upon the large attendance at the convention and upon the growth of the association during the past year, this growth being especially noteworthy as regards the character of the membership. Mr. Barker considered that the time had now come for greater scrutiny as to the character and standing of applicants for membership than heretofore, and he believed that with the record which is now behind the association there should be a rapid growth in its membership from this time on. He considered also that the time had now come for the election of a president to serve for a term of years, instead of for a single year as heretofore. He would like to see the office of president of this association and of the National Founders' Association held by the same man—the associations retaining, in other respects, their individuality. The association, in his opinion, has now become too large, and the work devolving upon the president too great to ask any man with business of his own to attend to, to assume the presidency under existing conditions.

The association, he said, has now learned the economics of strike handling and how to conduct its work at a greatly reduced cost, as compared with the experience of previous years, and he considered that while some mistakes had been made during the past year, they were fewer than those made during any previous year.

He referred to the death of the former commissioner of the association, W. P. Eagan, and following his report suitable resolutions voicing the esteem in which Mr. Eagan was held by the association were passed.

The work of the present commissioner, Robert Wuest, was also referred to in complimentary terms, the work of the commissioner during the past year having been especially onerous by reason of the unusual number of strikes with which he has had to deal.

Mr. Barker referred to the committee appointed two years ago with a view to bringing about closer relations with the National Founders' Association and to the rejection of the report made by that committee by a narrow majority of the Founders' association. Following this a plan for a conference board representing both associations was developed and has been put into effect. One of the actions of this board has been to consolidate *The Open Shop*, published by this association, and the *Review*, of the Founders' association. He also referred to the revised constitution which has been drawn up after extended discussion by a committee appointed for that purpose.

The Report of the Commissioner

Following this came the report of the treasurer, Wm. Lodge, and following that the report of Commissioner Wuest, from which latter it was learned that during the year just passed the association has had to contend with more strikes than in any previous year of its history. The association has had 126 strike cases to deal with, in 13 of which the strikes had been prevented from coming to a head. In 113 cases strikes had resulted and of these 109 had been won. In the four cases which were lost the surrender was by the firms involved and not by the association, and in all those cases the membership of the firms had been canceled. Eleven of the strikes had been against prohibitionary members and the expenses had been defrayed by them, the remaining 98 having been conducted at the expense of the association, at a gross cost of $86,406.

The report called attention also to the contemplated federation of the various labor unions engaged in the metal trades and to the fact that the strength of these organizations is largely in the railroad shops, of which the managers prefer the agreement method of dealing with them.

Following the report of Mr. Wuest came the report of the secretary, N. W. Dingwall, which gave details of the various strikes together with the expense involved in connection with each one.

The Report of the Committee on Education

At the session of Wednesday afternoon the report of the committee on technical education was read by its chairman, William Lodge. He related the action of the authorities of the Winona Technical Institute at Indianapolis, by which they agreed to establish a school of the machinist's trade in consideration of the finding of equipment and a scholarship fund by this association, and stated that equipment to the value of about $6000 had now been secured, together with about $4100 of the $12,000 stipulated for the scholarship fund.

One of the developments growing out of the correspondence in connection with the subscriptions was the gratifying manner in which those approached had replied that they were already establishing schools of their own. The report closed with an appeal for additional subscriptions, both to the equipment and to the scholarship fund, and it is understood that before the meeting adjourned this appeal had met with a gratifying success.

The report was followed by an active discussion in which the keen interest of the members of the association in the entire subject of industrial education was clearly brought out. A motion was made and well defended in favor of the appropriation of the necessary funds to the Winona school from the association's funds, the idea being that the association could well afford to establish one trade school as an object lesson of what is possible in such a school conducted by manufacturers. Opposed to this was the idea that the Winona school can only be, in effect, a local school and that other schools which will undoubtedly follow it in other localities will have just as much claim upon the association as this one, and after considerable discussion this view prevailed.

The New British Patent Law

The next matter to claim the attention of the convention was the new patent law of Great Britain to which we have referred upon another page. Decided feeling was manifested, the opinion being general that the time for action had arrived and that the President and Congress should be petitioned in favor of a similar law here, and the desirability of bringing the matter to the attention of the National Association of Manufacturers was also brought up. Eventually a resolution was passed calling for the appointment of a committee to deal with the subject and this was followed by another resolution instructing the secretary to bring the action of the association before the National Association of Manufacturers by an official communication.

A highly successful banquet and vaudeville entertainment was held Wednesday evening, at which an address on industrial education was delivered by Dr. Henry S. Pritchett and another by Hon. Wm. H. Spear, who discussed some dangerous modern tendencies.

The New Constitution

Following the formal session of Wednesday afternoon a caucus was held in order to discuss the new constitution referred to in the president's report and the report of this caucus was presented at the session of Thursday morning. Resolutions passed at the caucus favored action by the administrative council by which the membership is to be informed of the present status of the new constitution, and at the same time the local branches are to be asked to formulate their objections and their suggestions for amendment of it. Upon the receipt of these proposed amendments the administrative council is to make a new draft of the constitution and submit it to the membership for action by a mail ballot. This recommendation was adopted by the convention.

ENGINEERING AND INDUSTRIAL EDUCATION

Following this came an address by Prof. Herman Schneider, of the University of Cincinnati, in which he described the coöperative engineering work now being carried on between that university and the manufacturers of Cincinnati, of which our readers have already been informed. Perhaps the most striking feature of Professor Schneider's address was the figures which he gave regarding the growth of the idea. At the start both the university authorities and the manufacturers with whom the subject was discussed had very grave doubts regarding the possibilities of obtaining students to undertake such an onerous course of work, and as a matter of fact, for the entering class of the first year but 75 applicants were found, from whom 44 were selected. For the second year there were 800 applications, of which 60 were accepted and for the third year, which begins next fall, there are already over 700 additional applications on file, with others coming in at the rate of 50 or 60 a week, the indications being that a total of over 2000 will be reached before the time for the selection comes. Of course, under present shop conditions the number selected will be limited to those who can be accommodated by the shops and it is probable that the number of students selected from a probable list of 2000 will not exceed 50.

Professor Schneider stated that no friction whatever had developed in the shops by reason of the change of men week by week. A portion of each Saturday is spent in the shops by the students who are to take their associates' places the following Monday in order to familiarize themselves with what is then being done and especially with the new work that has been taken up during the previous week.

Professor Schneider was followed by Fred A. Geier, who declared the plan to be a proved success. The boys are found to be of such a superior class that the foremen of the shops are anxious to get all of them that they can. He stated frankly that the boys are not a source of expense to the shops, but on the contrary a source of profit almost from the beginning. He appealed for a greater degree of attention to the entire subject of education on the part of manufacturers, and passing on from Professor Schneider's topic he took up the subject of apprentices' schools, of which one has been inaugurated at the works of the Cincinnati Milling Machine Company, the results of which he considers remarkable.

He considered that the manufacturers must themselves inaugurate the industrial educational movement, first by starting shop schools and then by agitating the subject each in his own community. He referred to the work of the foundry school at the Winona Institute, which was last year placed upon a commercial basis, a profit-sharing plan between the school and the students having been adopted, as a result of which earnings as high as $12 a week have been secured by the students, and to prove the quality of the work turned out he referred to letters from ten shops which had used the castings made at the school and found them entirely satisfactory.

Mr. Geier was followed by E. F. Du Brul, who returned to the subject opened up by Professor Schneider. He regarded the plan as already a proved success and declared that every engineering school located in industrial centers should adopt it. He asked those present what they would think of the chance of selecting apprentices from boys averaging 18 years of age, all of whom were high-school graduates and imbued with the determination to learn and get on, and added that this plan opened the way to the selection of such apprentices and, as experience showed, to take the cream of a large number of applicants.

The entire discussion was pervaded with the keenest interest, the remarks of the speakers whose names have already been given being received with the warmest applause, as was the remark by another speaker that this association has much more important work before it than the fighting of strikes.

Following this came a report of the committee on legislation which, however, was of a general character only, and following this came a paper on recent legislations, which was not read.

THE NEW OFFICERS

The reports of the nominating committee were then presented, the selections being: For president, F. J. Copeland; for first vice-president, H. B. Eels; for second vice-president, J. H. Schwacke; and for treasurer, Wm. Lodge. W. H. Pfahler, who had been an honorary member of the administrative council since the organization of the association, was re-elected, and retiring president Barker was also elected an honorary member of the council. The nominations were received with the warmest kind of approval, and the nominees were elected at short notice.

Commenting on the rapidity with which coal mines are being opened in India, a Calcutta journal says: The increase of coal production may necessitate the adoption of machinery such as has been so sucessfully brought into use principally in America; indeed, the use of coal-cutting and coal-raising machinery in the United States has brought up the output per miner per annum to 560 tons, whereas in Great Britain they get only 282 tons per miner, and in Germany, France, and Belgium considerably less.

A. S. M. E. Monthly Meeting

The next monthly meeting of the American Society of Mechanical Engineers will be held in the auditorium of the Engineering Societies Building, New York, on the evening of April 14. The general subject of the meeting is the Conservation of our Natural Resources, which is now receiving unusual attention, because of the invitation of the President of the United States to the governors of the several States, and to the presidents of the national engineering societies, to confer with him in Washington on this important problem. The meeting will be addressed by four speakers who will consider forest preservation in its relation to water power, economy in the utilization of fuels, and the attitude of the engineer in regard to these. Dr. Henry S. Pritchett, president of the Carnegie Foundation for the advancement of teaching, will be one of the speakers and will discuss the "Relation of the Engineer to the Body Politic."

Power Losses in High-speed Belts

BY A. S. DICKINSON

A short time ago I was called upon to make an efficiency test on a high-speed centrifugal pump. The problems encountered in carrying out this test may be new to some readers of this journal, and the means of solving them may be of assistance to others.

A motor delivering 50 horse-power at the shaft, running at 850 revolutions per minute had a pulley 15 inches in diameter belted to a 10-inch pulley on the pump. This pump pulley indicated 1150 revolutions per minute when it should have been 1275 revolutions per minute. The first necessity was to find the amount of the loss of the horse-power transmitted due to the 125-revolution slip. The belt was a new eight-inch double leather belt, 5/16 inch thick, of first-class make and had been treated with a high-grade belt dressing to make it pliable. This treatment extended over a period of one week and the belt was in condition to run slack so that the top almost touched the bottom when running and pulling on the bottom side. The general position was nearly horizontal. Various suggestions were made by witnesses of the test, to the effect that the loss in power transmitted due to the belt would amount to from 6 per cent. to 20 per cent. of the total. One person stated that he knew this loss would run anywhere between 20 and 60 per cent.

Measuring the horse-power of the pump when running free and deducting this from the motor horse-power produced no results, because in this case the slipping did not take place. The tension on the belt was very small compared to that at

full load. The friction of the pump bearings did not enter into our problem because that item was counted against the efficiency of the pump itself. In considering the losses due to the belt we estimated first, that due to the slip and second, that due to the tension on the belt or its stiffness on the pulley face. In the first calculation, the tension on the belt transmitting 50 horse-power is about 500 pounds as derived from the well-known formula

$$T = \frac{63000 \times \textit{horse-power}}{N \times R},$$

when N is the revolutions per minute and R the radius of the pulley. Under the conditions stated above, the pump pulley should run 1275; since the indicated speed was only 1150 the loss was 125 turns. This corresponds to "lost travel" and is equal to $125 \times 3.1416 \times 10$ inch or 327 feet per minute. The tension of the belt being 500 pounds, the amount of power lost will be approximately equal to

$$\frac{327 \times 500}{33000}$$

or 4.96 horse-power or very nearly 10 per cent. Deducting this amount from the total of 50 horse-power leaves 45.04 horse-power.

In the second calculation for loss due to the rigidity or stiffness of the belt we find more serious problems. The thickness and age of the belt are important factors, as well as the quality of the leather and the diameter of the pulley upon which it runs. Very few if any data are obtainable on the subject. But from an old author we found: loss in efficiency in percentage for new double belts,

$$\frac{400 \times C^2 (d + D)}{d \times D},$$

when C is the thickness of the belt in inches and d and D the diameters of the pulleys. Applying the data in the above case to this formula we find the loss from this source to be 6.5 per cent. Then taking 93.5 per cent of 45.04 horse-power we have about 42.1 horse-power, which is the amount actually transmitted to the pump shaft.

The efficiency of the belt transmission thus appears to be not more than 84.2 per cent. and the loss of power 15.8 per cent. It is customary in estimating for the proper working of belts on pulleys, to make the smallest pulley not less in diameter than 50 times the thickness of the belt, so that in this case the 10-inch pulley should not have been less than 15 inches in diameter to conform to the rule for good working conditions. After all these calculations were finished several practical tests were made on the belt with apparatus specially designed for the purpose. The actual loss in transmission was found to be 19.5 per cent. Of course, the figures above have been rounded off for this numerical illustration and the actual percentage of loss calculated from exact figures by the formula given approaches very closely to the amount found by experiment.

The formula given is not claimed to be correct but is a rough approximation for purposes of calculation as to losses on good pliable belts when the pulleys are of sufficient diameter and the speeds not exceeding 40 feet per second. As a rule belt owners or operators do not think of their belts at all until they break. They are sometimes so far neglected that in the case of one factory investigated, the "loss" in power transmitted from the engines to the high-speed wood planers was found to be 60 per cent. This was due to rigidity, slackness, small pulleys and the slope of the belts. The engines were considered too small to do the work required. After the belts were properly cared for there was an excess of power in the engines.

Business Items

The Northern Engineering Works, Detroit, are building two 3-motor, 66-foot span, electric traveling cranes for export to Japan.

The firm name of the Schellenbach & Darling Tool Company, Cincinnati, Ohio, manufacturers of reamers, has been changed to the Schellenbach-Hunt Tool Company, W. P. Hunt having purchased the interest of J. W. Darling.

Curtis & Curtis Company, Bridgeport, Conn., manufacturer of the Forbes patent die stock, has recently shipped six machines to Russia, five to Australia, five to England, eight to Japan, three to Mexico and several to South America and British Columbia.

Among the orders recently received by the General Electric Company are the following: 300 four-motor equipments for the Chicago Railways Company; three 1000-kilowatt, 2300-volt three-phase alternators for the Manchurian Railway, Corea; 25 GE-202, 600-volt, two-motor equipments, and 40 type H oil-cooled transformers for the Sao Paulo Light and Power Company, Sao Paulo, Brazil. A shipment of two 50-kilowatt cross-compound marine sets together with switchboards and necessary instruments has been made to Olongapo, P. I. These will be used in the United States Government dry dock, Dewey, which recently made the trip around Cape Horn.

Trade Catalogs

W. H. Nicholson & Company, Wilkes-Barre, Penn. Circular illustrating and describing expanding lathe mandrels.

Hardinge Bros., 1034-1040 Lincoln avenue, Chicago, Ill. Catalog of Beyers watchman's portable clock. Illustrated, 16 pages, 6x9 inches, paper.

Lincoln-Williams Twist Drill Company, Taunton, Mass. Catalog and price list of high-speed twist drills. Illustrated, 16 pages, 6x9 inches, paper.

Cleveland Crane and Car Company, Cleveland, Ohio. Catalog electric traveling cranes, hand-power cranes, etc. Illustrated, 46 pages, 9x12 inches, paper.

Coates Clipper Manufacturing Company, Worcester, Mass. Bulletin No. 21, describing flexible shafts, grinding heads, angle drive, polishing outfit, etc. Illustrated, 44 pages, 6x8 inches, paper.

Goldschmidt Thermit Company, 90 West street, New York. First number of a publication called Reactions to be issued quarterly and which is devoted to the science of aluminothermics.

Link-Belt Company, Nicetown, Philadelphia, Penn. Catalog No. 75 describing different chains. Illustrated, 208 pages, 6x9 inches, paper. Also pamphlet of instructions as to proper method of using Ewart detachable link-belting.

Sloan & Chace Manufacturing Company, Ltd., Sixth avenue and North Thirteenth street, Newark, N. J. Loose-leaf catalog describing precision machinery including drills, bench lathes, gear cutters, etc. Illustrated, 8x9 inches.

Western Electric Company, Hawthorne, Ill. Bulletin No. 5910-2, describing power equipment for boot and shoe factories. 8x10½ inches. Bulletin No. 5910-3, describing power equipment for cement mills. Illustrated, 24 pages, 8x10½ inches.

Manufacturers

The Mutual Package Company, Buffalo, N. Y., will erect a box factory.

The National Paper Box Company, Kansas City, Mo., will erect a new plant.

The Ottumwa (Iowa) Bridge Company may move its plant to Houston, Texas.

The Mitchell Motor Car Company, Racine, Wis., is building additions to the plant.

The Waterbury (Conn.) Manufacturing Company, making brass goods, is to put up new buildings.

The Louisville (Ky.) Car Wheel Company has about completed arrangements for proposed new plant.

The Oil City (La.) Machine Company has been organized to deal in and manufacture oil-well machinery and supplies.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machine Co., 133 Oliver St., Boston.

Model making. Patented machines manufactured on royalty. Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y.

Wanted—Second-hand Rivett back geared 8-inch precision lathe and attachments in good condition. C. Nutter, Topeka, Kan.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Inventions, novelties, ideas, etc., developed; special machines designed. Albert Pott, M. E., 23 Platt St., New York, and Waterbury, Ct.

If you have a copy of March 7, 1907 AMERICAN MACHINIST we'll give you fifteen cents for it. AMERICAN MACHINIST, 505 Pearl St., New York.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Wanted—To manufacture and sell, patented specialties that are in use. Will buy or pay royalty. Hurley Machine Co., Chicago, Ill.

Gears cut to order, bevel, spur and miter, on Bilgram and Gleason machines. Complete gears furnished. The Cincinnati Gear Works, Murdock Building, Cincinnati, Ohio.

Special machinery designed, new ideas developed to practical results; tell me the conditions you wish to improve and I will do the rest. Box 950, AMERICAN MACHINIST.

Mechanical engineer or machinery man desired as partner in my business; must invest; good salary; I have bank references; successful. Box 10, AMERICAN MACHINIST.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Draftsmen, designers, machinists' reference sheet, 8"x13", containing 15 tables constantly used in shop practice, sent for 10c. (stamps). W., 2092 Washington Ave., New York.

Hardening tool steel to diamond temper, but tough inside, is an art; learn it free; no cracks or warping; endorsed by all experts; booklet. A. W. King Company, Rogers Park, Chicago.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Reputable manufacturer of hand and electric traveling cranes and new patent chain block desires to form connection with reputable agents both in this and foreign countries. Climax Hoist Co., Philadelphia, Pa.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

New British patent laws; high-class engineering firm with modern plant is open to quote favorable terms for building engineering specialties or machine tools in England. The Simplex Engineering Co., Ltd., Trafford Park, Manchester.

English firm, specialists in high-class automatic machinery and gear cutting, is prepared to take up the manufacture of similar machines (covered by English patents). The works are equipped with the very latest and most modern plant, being entirely self-contained, situated in center of iron and coal industries; contractors to the English, French, Italian, Austrian, Portugese, Roumanian and Servian governments; established 25 years; having agencies in all parts of the country, would also undertake sales and commercial management; having an extensive foreign trade, can arrange for inspection of our manufactures in almost any part of the world. Box 1, AMER. MACH.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Designer wishes to make a change, six years' experience in automatic machine tools, special machinery, jigs, fixtures and tools; any location satisfactory. Box 5, AM. MACH.

ILLINOIS

Superintendent, 38, practical mechanic, highly successful manager of men, interchangeable work, moderate salary. Box 933. AMERICAN MACHINIST.

Designer with technical education, shop training and an extensive experience with leading manufacturers on shop equipment, special machinery, tools and fixtures, wants a position. Box 11, AMERICAN MACHINIST.

Mr. Manufacturing Plant Manager, can you use a master mechanic, who has technical training (steam, electrical and mechanical), and who is a thorough practical mechanic, with 11 years' actual experience, and of proven ability, in the installation, operation and maintenance of modern up-to-date power equipment; one who can decrease cost of operation and increase output; one who is thorough in the handling of steam, electric, air pumps and fire apparatus and especially strong in individual and group drive; one who will accept salary in accordance with saving effected, and one who is not afraid of tools or overalls. If so would like to meet you; good reasons for seeking a change; can give the best of references. Box 4, AM. M.

MASSACHUSETTS

First-class metal patternmaker, experienced on hand and molding-machine patterns, wishes position. Will go anywhere. Box 938, AMERICAN MACHINIST.

MICHIGAN

Mechanical engineer, having designed a line of gasolene and producer gas engines of an improved modern type, wants to have position with concern for the manufacturing of same. Had responsible position for several years with leading German firm. First-class references. Box 983, AMER. MACHINIST.

NEW JERSEY

Chief draftsman, experienced on steam, gas, oil engines, turbines, air, ammonia compressors, centrifugal pumps, inventor and executive, wants responsible position. Box 966, AMERICAN MACHINIST.

NEW YORK

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Mechanical draftsman, wishes position. Address Box 992, care AMERICAN MACHINIST.

OHIO

Thoroughly competent wood patternmaker desires position; will go anywhere. Box 3, AMERICAN MACHINIST.

Position as machine shop foreman, chief engineer, or master mechanic; 12 years' experience; well read and up to date; will consider suitable position anywhere in United States; $1500 per year or better. Box 2, AMERICAN MACHINIST.

WISCONSIN

Wanted—Position as assistant superintendent. Technical graduate, a producer familiar with modern shop and drafting room practice. Box 982, AMERICAN MACHINIST.

FOREIGN

Master mechanic; American; age 37; responsible man with large and varied experience manufacturing, erecting and maintaining; successful in producing high grade work at lowest cost; at liberty July 1; Pacific Coast States only; state salary. B. Nilius, Master Mechanic, Rio Blanco, Peru, via Lima.

Help Wanted

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS

Pump Doctors—Expert repair men wanted by manufacturers of trade steam, power, electric driven pumps and small engines. Box 958, AMERICAN MACHINIST.

MICHIGAN

Salesman for your state for remarkable fuel and labor saving device for boilers selling for $50. Over 20,000 in use in the U. S. and Canada. Also hardware salesman to carry as side line our wonderful newly patented spirit level. Diamond Power Specialty Co., Detroit, Mich.

NEW JERSEY

Wanted—First-class designer and originator on hydraulic work, pumping engines, air and steam machinery. Must be fully competent to work out designs, practical experience, ability to redesign, develop and improve requirements. Address with full details, Box 957, AMERICAN MACHINIST.

NEW YORK

Wanted—Iron foundry foreman experienced on valves and fittings preferred; in replying state if now employed, age, experience, salary expected, furnish references; steady position for right man. Box 8, AMER. MACH.

Wanted—Assistant foreman for iron foundry capable of taking charge of molding machines especially; give references, state detail, experience and class of work at present employed; state wages expected and age. Box 9, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First-class gas-engine draftsman, one with steam and good shop experience preferred. Box 7, AMERICAN MACHINIST.

For Sale

For Sale—Patents for a door lock with burglar-proof link allowing partial opening of door; can be manufactured cheaply; profits large. Apply to Charles Weiser, Receiver, Kalb & Berger Mfg. Co., 49 Exchange Place, New York, N. Y.

Complete factory making gas, gasolene and crude oil engines, high class tools, buildings, land, railroad spur track, patterns and good will; located in Missouri, in heart of richest gas and oil fields in United States; good reasons for selling. Box 6, AMER. MACH.

The patent of a positive friction clutch for transmitting from ½ to 15 horse-power, regardless to speeds; its marvelous action, design, simplicity and cheapness of manufacturing is the sensation in every engineer circle of the country and Europe, and the only one remedy of all clutch troubles is for sale or open for an incorporation. Address "High Grade Investment," AM. MACH.

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Best & Co., L., New York.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.

Abrasive Materials—*Cont.*

Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Agents, Machinery

Churchill & Co., Chas., London, Eng.
C. I. F. Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

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Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.

Arbor Presses—*Continued.*

Wilmarth & Morman Co., Grand Rapids, Mich.

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Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.

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For Machinery, Automobiles, Bicycles, etc.

Hand (feed) Milling Machines.

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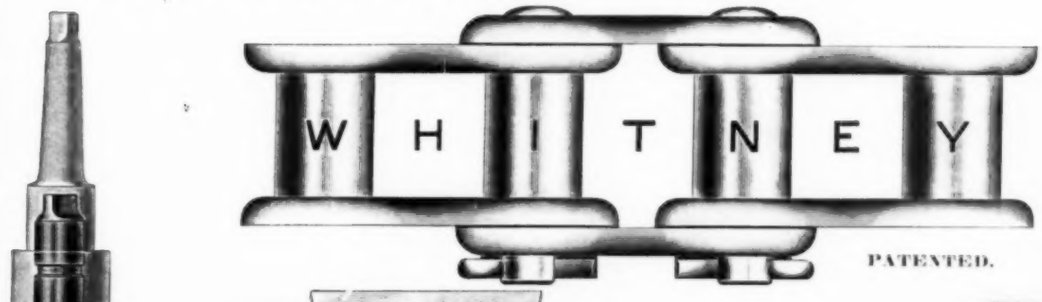

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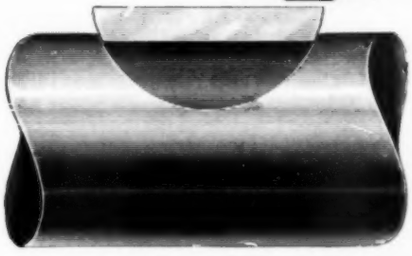

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Hartford, Conn., U. S. A.

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Wilmarth & Morman Co., Grand Rapids, Mich.

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Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

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Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Schieren Co., Chas. A., New York.
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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

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Bertsch & Co., Cambridge City, Ind.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
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Swaine Mfg. Co., Fred. J., St. Louis, Mo.

Bending Tools, Hand

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

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Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand.

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.

Blowers—*Continued.*

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Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
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Keuffel & Esser Co., New York.

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Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manville Mach. Co., E. J., Waterbury, Conn.
McCabe, J. J., New York.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.
National Machinery Co., Tiffin, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang & Co., G. R., Meadville, Pa.

Bolts and Nuts

Cleveland Cap Screw Co., Cleveland, O.
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Sames, Chas. M., Jersey City, N. J.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co, New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.

Boring and Drilling Machines, Horizontal—*Cont.*

Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co. Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Box Tools, Roughing

Bardons & Oliver, Cleveland, O.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine and Tool Co., Toledo, Ohio.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schiemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Castings, Brass and Bronze

Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Chisholm & Moore Mfg. Co., Cleveland, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Taylor & Fenn Co., Hartford, Ct.

Castings, Steel

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Mass.
Cammel, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Krupp (Thos. Prosser & Son), New York.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co, Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chisels, Cold

Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

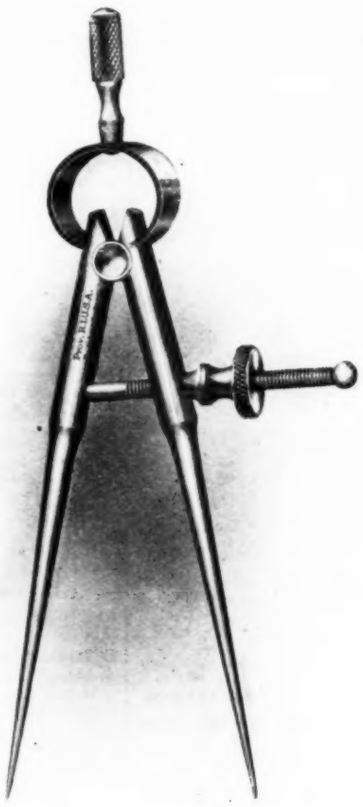
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co. R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Lancaster Knife and Machine Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.



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are intended for those who desire accurate measurements.

Accuracy Is Their Chief Characteristic

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Features Which Make Accuracy Durable.

The legs are drop forgings, finished in the best possible manner.

The spring is stiff and of an improved form.

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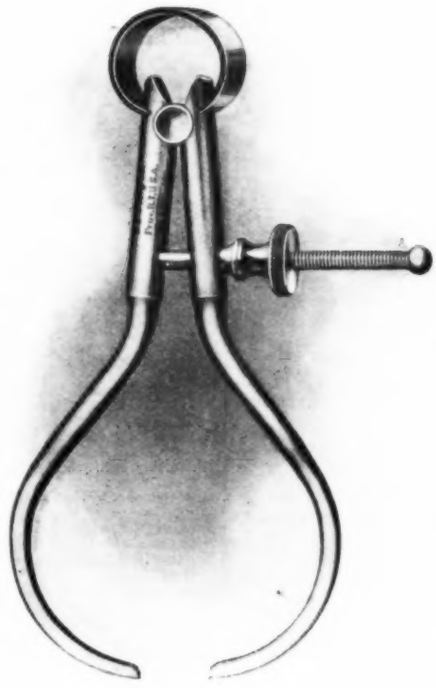

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sent to any address, describes the full line of Calipers and Dividers.

Chucks, Planer

Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn N. Y.

Clutches, Friction

Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Compound, Core

Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Dietz Machine Works, Phila., Pa.
Manville Bros. Co., Waterbury, Conn
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

Cranes

Brown Hoisting Mach. Co., Cleveland, O.
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Krupp (Thos. Prosser & Son), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas and Ladles, Foundry

Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks., Inc., Philadelphia, Pa.
Nutter & Barnes Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.

Dies, Sheet Metal—*Cont.*

Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co. Cleveland, O.
Manville Bros Co., Waterbury, Conn.
Risdon Tool Works, Waterbury, Conn.
Swaine Mfg. Co., Fred J., St. Louis, Mo.
Toledo Machine and Tool Co., Toledo, Ohio.

Dies, Sub-Press

Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Allen Co., Chas. G., Barre, Mass.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler

American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

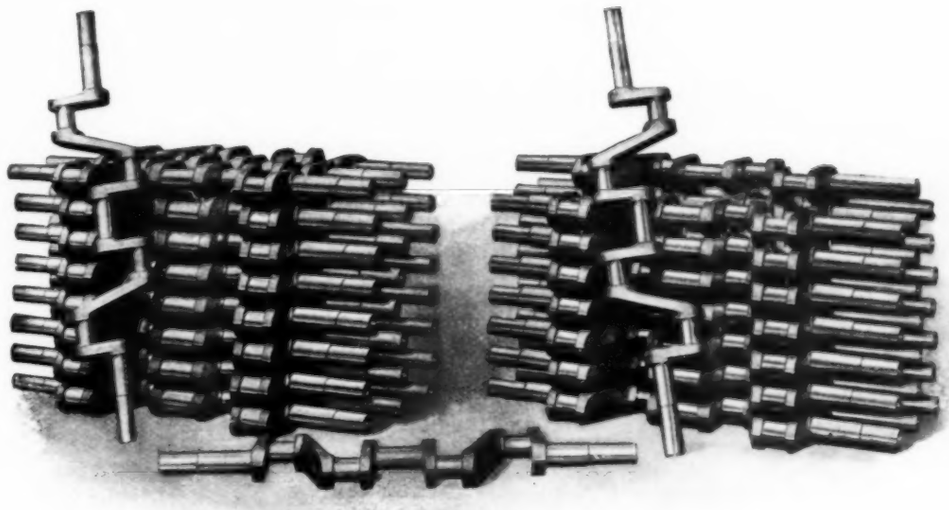
Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.

Drilling Machines, Multiple Spindle

Allen Co., Chas. G. Barre, Mass.
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Mach. Co., Hartford, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Landis Crank Grinding Machines



STEEL FORGINGS—case hardened – parts ground, four wrists each 1¾" diameter by 3½" long, three journals each 1⅞" diameter 3½"-4½" and 5½" long respectively, two gear pistons on end of shaft each 1⅝" diameter by 3" long.

A total of nine bearings all having been ground to size within .0005" variation limit, .025" diameter removed, average time taken 2 hours. This includes the grinding and accurately forming of twelve ⅛" radius fillets at ends of the bearings.

The above example of every day practice done with our No. 24 Crank Grinder is convincing evidence of this machine's true worth.

Write and ask us about the "LANDIS" and say "send me catalogue" and you will receive one immediately.

LANDIS TOOL COMPANY, Waynesboro, Pa., U. S. A.

AGENTS—Modern Machinery and Engineering Co., 309 Schofield Bldg., Cleveland, Ohio. Marshall & Huschart Machinery Co., 64 So. Canal St., Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

Drilling Machines, Multiple Spindle—*Continued.*

Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Fay Machine Tool Co., Phila., Pa.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

Allen Co., Chas. G., Barre, Mass.
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Co., Tool Co. Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Mach. Co., Hartford, Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.

Drilling Machines, Upright —*Continued.*

Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Ingersoll-Rand Co., New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Cleveland Twist Drill Co. Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Sampson Co., Geo. H., Boston, Mass.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cincinnati, O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Works Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.

Electrically Driven Tools and Machinery—*Continued.*

U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-Room

Hart & Cooley Co., New Britain, Conn.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical

Crocker-Wheeler Co., Ampere, N. J.
Jackson, Henry Docker, Boston, Mass.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.

Engines, Motor .

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam

Garden City Fan Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition, Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Export

Churchill & Co., Chas., London, Eng.
C. I. F. Co., New York.

Eyelet Machinery

Manville Bros. Co., Waterbury, Conn.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Crocker-Wheeler Co., Ampere, N. J.
Garden City Fan Co., Chicago, Ill.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.

Files and Rasps—*Continued.*

Nash Co., Geo., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Fittings, Iron

National Tube Co., Pittsburg, Pa.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burk Machy. Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
Krupp (Thos. Prosser & Son), New York.
O. K. Tool Holder Co., Shelton, Conn
Page Storms Drop Forge Co., Springfield, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Steel

Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Goldschmidt Thermit Co., New York.
Krupp (Thos. Prosser & Son), New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

MORSE TAPER SHANK DRILLS
FITTING ANDREW'S SOCKET.

The above cut represents the shank of the drill used in the Andrew's Socket. The drills are held in place by the key in the socket. As the groove extends the entire length of the shank, there is no difficulty in PLACING the shank in the proper position.

The groove in the shank is deeper near the shoulder than at the outer end of the shank which prevents the drill from being pulled out of the socket as well as from turning in it.

Arbors
Chucks
Counterbores
Countersinks
Cutters
Dies
Drills
Gauges
Machines

REMEMBER

Morse Twist Drill and Machine Company,
New Bedford, Massachusetts, U. S. A.

"MORSE" TOOLS.

Mandrels
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Sockets
Taps
Taper Pins
Wrenches

ANDREW'S PATENT DRILL SOCKETS
FOR TAPER SHANK DRILL.

These Sockets are fitted with a Key sliding in a radial slot in the holding head. The key bears upon the inclined seat in the shank of the drill and is forced to its seat by a cap fitting over the holding head. Turning the cap by the hand in one direction holds the drill firmly in place while turning it in the opposite direction releases its grip so that the drill can be easily removed.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Ames & Co., B. C., Waltham, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear and Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear and Machine Co., Chicago, Ill.
Gleason Works, Rochester, Mass.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Morse, Williams & Co., Phila., Pa.
Mutual Machine Co., Hartford, Conn.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees-Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburg & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
Morse, Williams & Co., Philadelphia, Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electrical Mfg.Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. P., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter

Bath Grinder Co., Inc., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Cutter—*Continued.*

Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disc

Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Taylor & Fenn Co., Hartford, Conn.

Grinders, Drill

Heald Mach. Co., Worcester, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Knife

American Wood Working Mchy. Co., Rochester, N. Y.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
U. S. Electrical Co., Cincinnati, Ohio.

Grinders, Saw

Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Diamond Machine Co., Providence, R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Grinders, Tool—*Continued.*

Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery

Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Burk Machy. Co., Cleveland, O.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.
Gardner Mach. Co., Beloit, Mich.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machy. Co., Chicago, Ill.
McCabe, J. J., New York.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
National Mach. Co., Hartford, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Prentiss Tool & Supply Co., New York.
Safety Emery Wheel Co., Springfield, O.
Stow Mfg., Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels

Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Best & Co., L., New York.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Diamond Machine Co., Providence, R. I.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grindstones and Frames

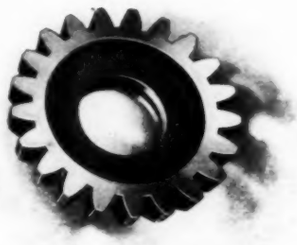
Cleveland Stone Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.

Gun Barrel Machinery

Diamond Machine Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop

Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.



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is Correct in Theory and is Found to be Equally so in Practice

This cutter has teeth in which the involute curve is generated by rolling the cutter tooth past an emery wheel in true rack and pinion movement, the cutter representing the pinion and the emery wheel one side of a rack tooth. This makes every cutter an original gear with generated teeth, and as this grinding is done after the cutter is hardened, it insures accurate work at all times.

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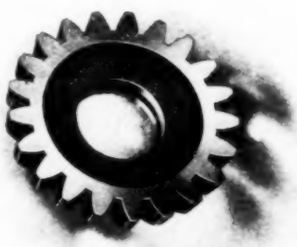

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Hammers, Drop—*Continued.*
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Bliss Co., E. W., Brooklyn, N. Y.
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Clayton Air Compressor Works, New York.
Ingersoll-Rand Co., New York.
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Sampson Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Steam
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Whitman & Barnes Mfg. Co., Chicago, Ill.

Heading Machinery, Cold
Manville Mach. Co., E. J., Waterbury, Conn.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
Garden City Fan Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

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American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

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Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Ct.
Schuchardt, & Schütte, New York.

Hoisting and Conveying Machinery
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, Ohio.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Yale & Towne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Yale & Towne Mfg. Co., New York.

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Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

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Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Carborundum Co., Niagara Falls, N. Y.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.

Igniters, Gas Engine
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston, Mass.

Indicators, Test
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Norton Grinding Co., Worcester, Mass.
Starrett Co., L. S., Athol, Mass.

Injectors
Desmond-Stephan Mfg. Co., Urbana, O.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Inspection and Tests
Hunt Co., Robert W., Chicago, Ill.

Instruments, Electric
General Electric Co., New York.

Iron Bar
Milton Mfg. Co., Milton, Pa.

Jacks, Hydraulic
Burroughs Co., Chas., Newark, N. J.
Watson-Stillman Co., New York.

Jacks, Planer
Armstrong Bros. Tool Co., Chicago, Ill.

Jacks, Lever and Screw
Watson-Stillman Co., New York.

Kettles, Soda
Brown & Sharpe Mfg. Co., Providence, R. I.
Gray & Prior Mach. Co., Hartford, Conn.
Mfg. Equip. & Engineering Co., Boston, Mass.

Key Seaters
Baker Gros., Toledo, O.
Burr & Sons, John T., Brooklyn, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Lapointe Mach. Tool Co., Hudson, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Morton Manufacturing Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Whitney Mfg. Co., Hartford, Conn.

Keys, Machine
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Conn.

Knives, Machine
Coes Wrench Co., Worcester, Mass.
Lancaster Knife and Mach. Wks., Lancaster, N. Y.
Simonds File Co., Fitchburg, Mass.

Lamps, Arc
General Electric Co., New York.
Turner Brass Works, Sycamore, Ill.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lathe Attachments
American Tool Works Co., Cin., O.
Bradford Machine Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
LeBlond Machine Tool Co., R. K., Cincinnati, Ohio.
Mossberg Wrench Co., Central Falls, N. Y.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Saunders Co., James, Dayton, O.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
LeCount, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.
Williams & Co., J. H., Brooklyn, N. Y.

Lathes
American Tool Works Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cincin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Cincinnati Lathe and Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Dreses Mach. Tool Co., Cin., O.
Fay Mach. Tool Co., Phila., Pa.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
Morris Foundry Co., Jno. B., Cincinnatil, O.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Saunders Co., James, Dayton, O.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mach. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Lathes, Automatic Screw-Threading
Automatic Machine Co., Bridgeport, Conn.
Fay Machine Tool Co., Phila., Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench
American Watch Tool Co., Waltham, Mass.
Ames & Co., B. C., Waltham, Mass.
Blount Co., J. G., Everett, Mass.
Hardinge Bros., Chicago, Ill.

Lathes, Bench—*Continued.*
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Waltham Machine Works, Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring
American Wood Working Mchry. Co., Rochester, N. Y.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Lathes, Brass
Bardons & Oliver, Cleveland, O.
Dreses Mach. Tool Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, O.

Lathes, Extension
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power
Barnes Co., W. F. & Jno., Rockford, Ill.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Gap
American Tool Wks. Co., Cin., O.
Harrington & Sons Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Speed
Blount Co., J. G., Everett, Mass.
Chicago Machine Tool Co., Chicago, Ill.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Wood
American Wood Working Mchy. Co., Rochester, N. Y.
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Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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Hart & Cooley Co., New Britain, Conn.
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Besly & Co., Chas. H., Chicago, Ill.
Gem Mfg. Co., Pittsburg, Pa.

Machinery Dealers
Besly & Co., Chas. H., Chicago, Ill.
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A Hendey-Norton Lathe with typical Tool Room Equipment, consisting of Oil Pan, Taper Attachment, Relieving Attachment.

A word regarding the RELIEVING ATTACHMENT. The Tool Slide is shown set at an angle. In this position it can be used up to 30 degrees for backing off cutters having side cutting teeth, such as used for milling flutes in taps, reamers, etc. The tool room finds it necessary in many cases to make cutters of this character frequently, and without a Relieving Attachment that can be SET AT PROPER ANGLE TO OBTAIN THIS SIDE RELIEF, you are seriously handicapped. Of course, the ordinary backing off of taps, hobs, formed cutters, is quickly and accurately done with this same attachment.

It has but one fixed cam, different divisions being obtained with a few change gears, the travel of tool being variable at will.

Furnished on 14", 16", 18" lathes.

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The Hendey Machine Co.

Torrington, Conn.

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A Paid-Up Accident Insurance Policy

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The "Johnson" saves space by its compactness. It operates smoothly at any speed without bang or clatter, and although small and having fewer parts than other clutches, it is more powerful than the best of them. Leading concerns are adopting it as a necessary part of machines.

SINGLE CLUTCH—EXTERIOR.

JOHNSON FRICTION CLUTCH DIS-ASSEMBLED
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Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
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Lufkin Rule Co., Saginaw, Mich.
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Pratt & Whitney Co., Hartford, Conn.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Schuchardt & Schütte, New York.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.

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Bemis & Call Hardware & Tool Co., Springfield, Mass.
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Hammacher, Schlemmer & Co., New York.
McCabe, J. J., New York.
Schuchardt & Schütte, New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

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Le Count, Wm. G., So. Norwalk, Conn.
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Nicholson & Co., W. H., Wilkes-Barre, Pa.
Schellenback & Hunt Tool Co., Cincinnati, O.
Western Tool & Mfg. Co., Springfield, O.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Ct.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

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Slate Machine Co., Dwight, Hartford, Conn.

Measuring Machines
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.

Mechanical Draft
Sturtevant Co., B. F., Hyde Park, Mass.

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Besly & Co., Chas. H., Chicago, Ill
Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Rowell Co., W. G., Bridgeport, Conn,

Meters, Cut
Warner Instrument Co., Beloit, Wis.

Meters, Electric
General Electric Co., New York.

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Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

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Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.

Milling Attachments—*Cont.*
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Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Rivett Lathe Mfg. Co., Boston, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Bench
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Burk Machry. Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg.Co.,Ltd., Newark, N. J.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Hand
Adams Co., The, Dubuque, Iowa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Milling Mach. Co., Cincinnati, O.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Horizontal
Adams Co., The, Dubuque, Iowa.
Beaman & Smith Co., Providence, R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Cincinnati Milling Machine Co., Cincinnati, O.
Hendey Mach. Co., Torrington, Conn.
Ingersoll Milling Mach. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Plain
Adams Co., Dubuque, Iowa.
American Tool Wks. Co., Cin., O.
Beaman & Smith Co., Prov., R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morton Manufacturing Co., Muskegon Heights, Mich.
Motch & Merryweather Machinery Co., Cleveland, O.
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Oesterlein Machine Co., Cin., O.
Owen Mach. Tool Co., Springfield, O.
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Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.
Warner & Swasey Co., Cleveland, O.
Whitney Mfg. Co., Hartford, Conn.
Wormer Mchry. Co., C. C., Detroit, Mich.

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Underwood & Co., H. B., Philadelphia, Pa.
American Tool Wks. Co., Cin., O.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O

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Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincin., O.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Prov., R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Garvin Machine Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.

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Pratt & Whitney Co., Hartford, Conn.

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Geometric Tool Co., New Haven, Conn.
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Moline Tool Co., Moline, Ill.
Mumford Co., E. H., Philadelphia, Pa.
Tabor Mfg. Co., Philadelphia, Pa.

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C & C Electric Co., New York.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
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Stow Mfg. Co., Binghamton, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
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Turner Brass Works, Sycamore, Ill.

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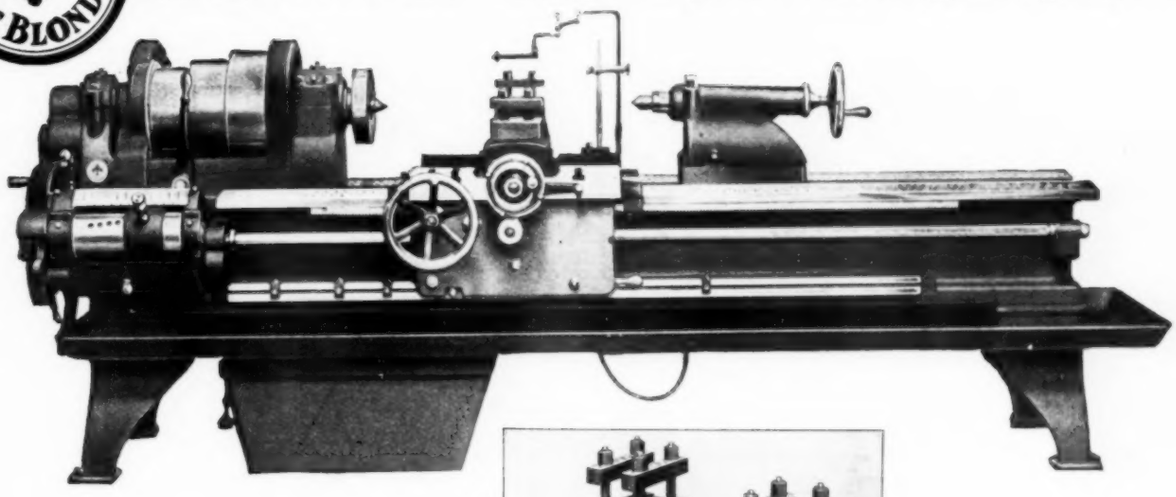

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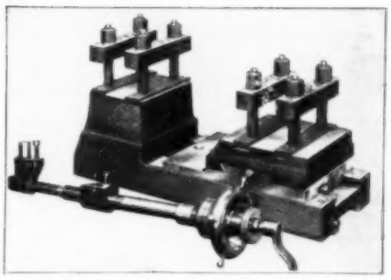

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Sellers & Co., Inc., Wm., Philadelphia, Pa.
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Fawcus Mach. Co., Pittsburg, Pa.
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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Screw Machinery, Wood and Lag

Baker Bros., Toledo, O.
Cook Co., Asa S., Hartford, Conn.

Screw Plates

Besly & Co., Chas. H., Chicago, Ill.
Brubaker Bros., W. L., Millersburg, Pa.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Screws, Cap and Set

Cleveland Cap Screw Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
National-Acme Mfg. Co., Cleveland, O.
Worcester Machine Screw Co., Worcester, Mass.

Screws, Machine

Cleveland Cap Screw Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
Machine Screw Products Co., Providence, R. I.
National-Acme Mfg. Co., Cleveland, O.
Standard Gauge Steel Co., Beaver Falls, Pa.
Universal Machine Screw Co., Hartford, Conn.
Worcester Machine Screw Co., Worcester, Mass.

Second Hand Machinery

American Tool Works Co., Cin., O.
Davis Machine Co., W. P., Rochester, N. Y.
Garvin Machine Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machinery Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machy. Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machry. Co., C. C., Detroit, Mich.

Separators, Oil and Steam

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Shafting

Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Shapers

American Tool Works Co., Cin., O.
Boynton & Plummer, Worcester, Mass.
Cincinnati Shaper Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Juengst & Sons, Geo., Croton Falls, N. Y.
Kelly Mach. Co., R. A., Xenia, O.
Marshall & Huschart Machinery Co., Chicago, Ill.
McCabe, J. J., New York.
Morton Manufacturing Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Q. C. Machine Tool Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith & Mills, Cincinnati, O.
Springfield Machine Tool Co., Springfield, O.
Steptoe Shaper Co., John, Cincinnati, Ohio.
Vandyck Churchill Co., New York.
Walcott & Wood Machine Tool Co., Jackson, Mich.

Shapers, Wood

American Wood Working Machry. Co., Rochester, N. Y.

Shears, Hand

Armstrong-Blum Mfg. Co., Chicago, Ill.

Shears, Power

Bertsch & Co., Cambridge City, Ind.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Mach. Co., Bridgeton, N. J.
Long & Allstatter Co., Hamilton, O.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Royersford Foundry & Mach. Co., Royersford, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Swaine Mfg. Co., Fred. J., St. Louis, Mo.
Toledo Machine and Tool Co., Toledo, Ohio.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Shears, Rotary

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.

Sheet Metal Working Machinery

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Machine Co., Bridgeton, N. J.
Toledo Mach. & Tool Co., Toledo, O.

Sheets

Phosphor Bronze Smelting Co., Philadelphia, Pa.

Shelving, Shop

Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mach. Co., New Britain, Conn.

Slide Rests

American Watch Tool Co., Waltham, Mass.
Betts Mach. Co., Wilmington, Del.
Blount Co., J. G., Everett, Mass.
Garvin Machine Co., New York.
National Acme Mfg. Co., Cleveland, O.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Reed Co., F. E., Worcester, Mass.

Slotters

Baker Bros., Toledo, O.
Betts Mach. Co., Wilmington, Del.
Dill Slotter People, Philadelphia, Pa.
Garvin Machine Co., New York.
McCabe, J. J., New York.
National-Acme Mfg. Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.

Slotters, Auto Screw

Manville Mach. Co., E. J., Waterbury, Conn.

Sockets and Sleeves

Cleveland Twist Drill Co., Cleveland, O.
Lancaster Machine and Knife Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Special Machines and Tools

Automatic Mach. Co., Bridgeport, Conn.
Beaman & Smith Co., Prov., R. I.
Bilgram, Hugo, Philadelphia, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bliss Co., E. W., Brooklyn, N. Y.
Cell Drier Machine Co., Taunton, Mass.
Cleveland Cap Screw Co., Cleveland, O.
Consolidated Press and Tool Co., Hastings, Mich.
Crescent Forgings Co., Oakmont, Pa.
Dietz Machine Works, Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Harrison & Knight Mfg. Co., Newark, N. J.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Mossberg Wrench Co., Central Falls, R. I.
Mueller Mach. Tool Co., Cin., O.
Pratt & Whitney Co., Hartford, Ct.
Q. C. Machine Tool Co., Cincinnati, O.
Schellenbach & Hunt Tool Co., Cincinnati, Ohio.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Smith, Chas. F., New York
Spacke Mach. Co., F. W., Indianapolis, Ind.
Standard Engineering Works, Ellwood City, Pa.
Swaine Mfg. Co., Fred J., St. Louis, Mo.
Taylor & Fenn Co., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.
Wellman Co., Medford, Mass.

Springs, Wire

Cleveland Wire Spring Co., Cleveland, O.

Spring Winders

Remington Tool & Mach. Co., Boston, Mass.

Sprockets

Baldwin Chain & Mfg. Co., Worcester, Mass.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cullman Wheel Co., Chicago, Ill.
Link-Belt Co., Philadelphia, Pa.
Whitney Mfg. Co., Hartford, Conn.

Stampings, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bay State Stamping Co., Worcester, Kass.
Globe Machine & Stamping Co., Cleveland, O.
Mossberg Wrench Co., Central Falls, R. I.

Stampings, Welded

Standard Welding Co., Cleveland, Ohio.

Stamps, Steel

Eastern Machinery Co., New Haven, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steam Specialties

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, Ohio.

Steel, Air Hardening

Carpenter Steel Co., Reading, Pa.
Firth-Sterling Steel Co., Pittsburg, Pa.

Steel Machinery

Carpenter Steel Co., Reading, Pa.
Cammell, Laird & Co., New York.
Firth-Sterling Steel Co., Pittsburg, Pa.
Nash Company, Geo., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Ward & Son, Edgar T., Boston, Mass.

Steel, Sheet

American Tube & Stamping Co., Bridgeport, Conn
Firth-Sterling Steel Co., Pittsburg, Pa.
Simonds File Co., Fitchburg, Mass.
Ward & Son, Edgar T., Boston, Mass.

Steel, Tool

American Tube & Stamping Co., Bridgeport, Conn.
Cammell, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Firth-Sterling Steel Co., Pittsburg, Pa.
Nash Company, Geo., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Ward & Son, Edgar T., Boston, Mass.

Steel, Tempering and Hardening Solution

Metal Hardening Solution Co., Rochester, N. Y.

Stocks, Die

See Taps and Dies.

Stones, Oil

American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls N. Y.
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Stools, Shop

Cleveland Wire Spring Co., Cleveland, O.
Manufacturing Equip. & Engineering Co., Boston, Mass.

Straightening Machinery

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fitchburg Machine Works, Fitchburg, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Springfield Machine Tool Co., Springfield, O.